FEB 1 1944

Ordnance Distinguished Service Award

presented to

Society of Automotive Engineers, Inc.

In recognition of outstanding and meritorious engineering advisory services in war and peace; in design, manufacture and maintenance of Ordnance matériel.

Award Authorized December 28, 1943

Ordnance Department, United States Army

Major General, U.S. Army
Chief of Ordnance

Major General, U.S. Army
Chief, Industrial Division

Major General, U.S. Army
Chief, Technical Division

Brigadier General, U.S. Army
Chief, Field Service Division

Brigadier General, U.S. Army
Chief, Tank-Automotive Center

"Never have so many owed so much to so few"

Those ringing words were not spoken of America's automotive engineers.

But they could have been.

Why America and our allies owe so much to the automotive engineers cannot yet be fully told.

But when it is told, the world will appreciate why we of Perfect Circle are proud to work side by side with them as they devote their skill and energy to this nation's immediate and future needs.

PERFECT CIRCLE

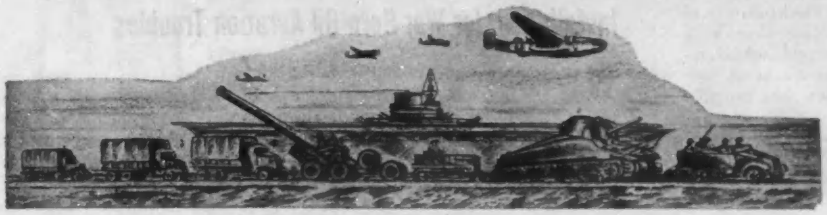
PC

PISTON RINGS

THE PERFECT CIRCLE COMPANIES, HAGERSTOWN, INDIANA, U.S.A. AND TORONTO, CANA

SAE JOURNAL *Pre-Prints*

THE SOCIETY OF AUTOMOTIVE ENGINEERS, INC.
29 W. 39TH ST., NEW YORK 18



News of the **MARCH** *Issue*

By Norman G. Shidle

Authority

AUTHORITY is fragile. To use it, often, is to lose it.

The man who finds most difficulty in stirring others to action without authority, is most likely to be clumsy in using it once it is given him. Authority is a tool to be applied with the deftness of an etcher's steel point. It breaks of its own weight when wielded with the uncompromising strength of a blacksmith's blow. Action motivated solely by authority is likely to be pedestrian, uninspired.

In theory, authority is delegated. In practice, it has to be earned.

From office to office, from factory to factory, the same title describes widely varying powers. Here, the advertising manager controls fully his company's advertising policy. There he is liaison between the company's executives and the advertising agency. Here, the research engineer plays a major role in determining features of the product the engineering department designs. There, he merely investigates as directed. Reason for the differences lies in the capacity for leadership of the men involved at least as often as in the executive policy of the company. The man capable of getting active, spirited cooperation from his employees and associates has strength that no officially delegated powers ever produced.

Clear delineation of authority within organizations is essential to smooth operation. It is the normal and efficient way to delegate responsibility.

Pay-off in results comes when recipients see the delegated authority as one of many tools necessary to fulfillment of their responsibilities. Trouble brews when delegated responsibilities are grasped as a chance to exercise authority.

HI-OCTANE VISIONS DAMPED BY REFINING EXPERTS WHO ENVISAGE SLOW INCREMENTS

HOW much 100 octane-number aviation gasoline will be available after the war? How will it be used? How will the availability of 100-octane gasoline and the equipment to make it affect the quality of motor gasoline?

Answers of Bruce K. Brown and D. P. Barnard, of the Petroleum Administration for War, to these and other timely questions on the effect of wartime fuel developments on post-war motor fuels will be given in March *SAE Journal*. The authors will undertake to project estimates that will indicate the limits within which these answers must fall.

Gasoline of 100-octane may *someday* become feasible as an automobile fuel, but that day will be described as far off. Evolutionary rather than revolutionary improvements in design, development, and construction will be explained as slowly bringing about an increase in octane number. But, the authors will warn, one must always remember that, at the high octane-number levels already prevailing, each succeeding octane-number improvement becomes increasingly difficult to achieve.

Average octane-number levels of motor gasoline, the authors will predict, may increase as much as three units over immediate pre-war values and the majority of marketers will be able to offer house-brand gasoline around 80 octane and a premium grade of around 85 octane.

These conservative figures will be based on the authors' expectation that an appreciable fraction of wartime high-octane gasoline refining facilities will be shut down or diverted to other services as promptly as possible because of operating costs and crude utilizations, justifiable as part of the war effort, but excessive under normal conditions. As a result, only a small fraction of facilities will produce high-octane aviation stock for use in motor fuels. The effect of their use will be appreciable but, the authors will contend, the result in octane numbers will be far below the mystic value of 100.

Tests Shed Light on Cause Of Controversy Over Plane Accessory Control Systems

UNREPORTED battle of the clouds has been the technical warfare waged these many years by opposing supporters of hydraulic and of electric accessory systems for aircraft.

Basically, it is an engineering controversy. Both systems function satisfactorily. Yet pro-hydraulics boastingly sing the praises of operating smoothness, and pro-electrics make retorts courteous, more or less, with sly remarks that wires do not drip. Party of the third part, composed of engineer realists fighting excessive gadgetry in any form, occasionally attacks the flanks, arguing that the simple life is the happy one and that aviation would be better off were much of the accessory equipment left on the ground.

Fact of the matter appears to be that certain accessory equipment, whether operated

* * *

General Barnes on Enemy Arms

The most complete analysis of captured enemy equipment ever published will appear in the March issue of the Journal, when an "Engineering Report" made by Major-Gen. G. M. Barnes, chief of the Technical Division, Army Ordnance Department, will be printed.

Gen. Barnes, who presented his technical paper on this subject at the Annual Meeting dinner in Detroit, has visited the major world battlefronts, was in Germany "in 1922 before the ink on the Versailles Treaty was dry," is in charge of the extensive enemy equipment museum and engineering testing laboratory for captured equipment at the Aberdeen Proving Ground.

* * *

by hydraulics or by electricity, in some cases becomes impedimenta in the air. Cases in point: The wheel retracting mechanism is of no more use to a flying plane than to a flying bird. Brakes add weight which retards speed. Bomb-bay doors are of no particular value to some planes, but essential equipment of bombers.

The controversy fairly will be explained in March *SAE Journal* by W. C. Trautman, of Bendix Aviation, Ltd., and R. E. Middleton, of Aircraft Accessories Corp. From their position as inquisitive referees, they will say that, for planes comparable in size, the hydraulic system weighs only 171 lb against 209 lb for an electric system to perform the same functions. The hydraulic system appears to be seriously affected by subzero temperaturess, and to require 100 ft of tubing to transmit power 50 ft. An electric generator consumes more fuel than a hydraulic pump, but also supplies radio equipment and lights.

Having made a general study of the weight and efficiency of the two systems, the authors will report that, excluding considerations of reliability, cost, and vulnerability to gun fire, these conclusions fairly may be reached:

- Each system has specific advantages.
- Both systems have rightful places in aviation.
- That system should be used which can contribute most to the efficiency of the plane.

Blame Disregard for Hydraulics, Poor Plumbing Installation, for War-Born Oil Aeration Troubles

WAR-BORN troubles shared by aircraft-engine and automotive engineers is oil aeration, a mechanical malady which alike and adversely affects the functioning of lubricating systems in planes flying above the earth and of tanks plowing along it.

Symptom of the trouble is oil froth and foam escaping from breathers and vents. Effect is intermittently to supply moving parts with shots of froth, foam, and air, usually at the very times they are working hardest and are in greatest need of oil.

Tendency of oil to undergo aeration in planes flying at polar altitudes has been no help at all in explaining why it appears also in the engines of tropically heated tanks. However, these contrasting phenomena have served to relieve the temperature of blame.

The whole problem, solution of which admittedly is tough, will be outlined in March *SAE Journal* by R. J. S. Pigott, of Gulf Research & Development Co. He will ascribe the difficulty chiefly to disregarding the elementary laws of hydraulics—and to kinks in the plumbing. And he will also suggest some corrective steps.

In the case of aircraft engines, Mr. Pigott will accuse the scavenge pump as being the chief culprit, and those who install oversize pumps as accessories before the fact. Pumps having capacity several times larger than necessary to supply maximum engine demand, Mr. Pigott will explain, mix a large percentage of air and blowby exhaust gas with the oil. With double-row aircooled, and with in-line, engines, he will say, the trouble is doubled by the use of duplicating pumps.

Mr. Pigott will indicate that other factors and other items of engine equipment also must be blamed, since all contribute to oil aeration. Fundamental difficulties will be said to handicap research, even in measuring the amount of air forced into oil by a pump. However, sufficient progress will be reported to support such conclusions as:

Centrifugal boosters largely can solve the problem. Pumps, such as positive-displacement rotaries which require no boosting, can be used. Oil tanks can be pressurized, and their design improved. Suction-side resistance of pressure or sump pumps, and velocities in suction piping, must be kept to a minimum.

Tests Reveal Engine Operating Roughness Has Multiple Causes

DESIRE of the American motoring public for smoothly operating engines in its cars coincides with automotive engineering ambition to produce engines free of roughness.

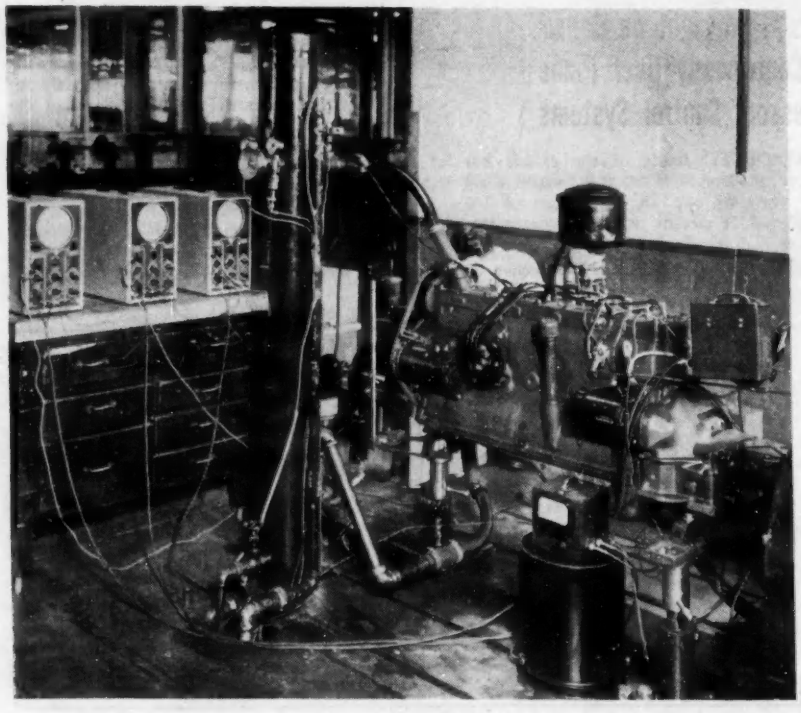
Both desire and ambition, however, are dependent upon accomplishing one prior objective – ascertaining the causes of roughness. Present state of progress indicates the causes are almost as numerous as engineering opinions concerning them. Even defining the term "roughness" is the subject of no little controversy.

March *SAE Journal* will publish a technical article by Dr. Lloyd Withrow and Dr. Arthur S. Fry, of General Motors Corp., Research Division, which will present interesting comparable data on the operating roughness, and its evident causes, in single-cylinder and eight-in-line engines. Interesting also will be an explanation of the application of oscillographs, microphones, and other sound-amplifying and recording instruments to this research project.

The article will ascribe to study of oscillograms made in tests the revelation that the sensation of roughness in both engines is closely related to a shock type of excitation developed in the crankshaft-flywheel system. Results of tests will be cited to indicate that roughness was altered in the single-cylinder engine by changes in the development of combustion pressures, and could be reduced by using a "flexi-disk" flywheel.

The authors will report that in the multi-cylinder engine, both the shock-type excitation of the crankshaft-flywheel system and the sensation of roughness could be affected in two ways – by changing the characteristics of pressure development, and by changing the piston weight. Exchanging cast-iron pistons for aluminum produced similar results.

The research project, terminated by the war, will be characterized as having substantial post-war values. The authors will explain that engines of post-war cars may operate on high-octane fuels at much higher pressures. Also, post-war need for fuel economy may require the installation of small engines of high specific output in light cars.



Set-up of engine in making roughness tests on the laboratory dynamometer stand, showing the three oscillographs used in recording sound pressures, vibrations, and pressures

S·A·E Journal

Published Monthly by The Society of Automotive Engineers, Inc.

SAE OFFICES

Headquarters

29 West 39th St. New York 18, N. Y.
Telephone: Longacre 5-7170

W. S. James, President

B. B. Bachman, Treasurer

John A. C. Warner, Secretary and General Manager

West Coast Branch Office

530 West 6th St. Los Angeles 14, Calif.
Telephone: Vandike 3915

E. F. Lowe, Asst. Gen. Mgr.

Detroit Branch Office for War Activities

808 New Center Bldg. Detroit 2, Mich.
Telephone: Madison 7495

R. C. Sackett, Staff Representative

SAE Journal

Editorial Office

29 West 39th St. New York 18, N. Y.
Telephone: Longacre 5-7174

Norman G. Shidle, Executive Editor

Advertising Offices

29 West 39th St. New York 18, N. Y.
Telephone: Longacre 5-7170

C. B. Whittelsey, Jr., Business Mgr.

E. L. Carroll, Eastern Adv. Mgr.
29 West 39th St. New York 18, N. Y.

A. J. Underwood, Western Adv. Mgr.
3-210 General Motors Bldg.—Detroit 2, Mich.
Telephone: Trinity 2-0339

The Society is not responsible for statements or opinions advanced in papers or discussions at its meetings or in articles in the JOURNAL.

JOURNAL INDEX AVAILABLE—A complete Index covering the twelve 1943 issues (Vol. 51) of the *SAE Journal* is now available to members and subscribers free upon request.

CONTENTS

FEBRUARY 1944

SAE War Engineering - Annual Meeting 17

Distinguished Service Award 20

News of the Society 22

SAE Officers for 1944 23

TRANSACTIONS SECTION

Speculations on Airworthiness and Operating Regulations - Edward Warner 37

Motion Analysis by Means of High-Speed Photography - - - H. D. Jackes 49

Characteristics of Plastics as Engineering Materials - W. F. Bartoe and Dr. D. S. Frederick 54

Experience with the Use of Magnesium in Aircraft - - - - J. C. Mathes 62

Stainless Steels - Hot and Otherwise - - - - - - - H. A. Campbell 67

Cooling-System Maintenance 29

Technical Ideas for Engineers 50

About SAE Members 54

Applications Received 58

New Members Qualified 59

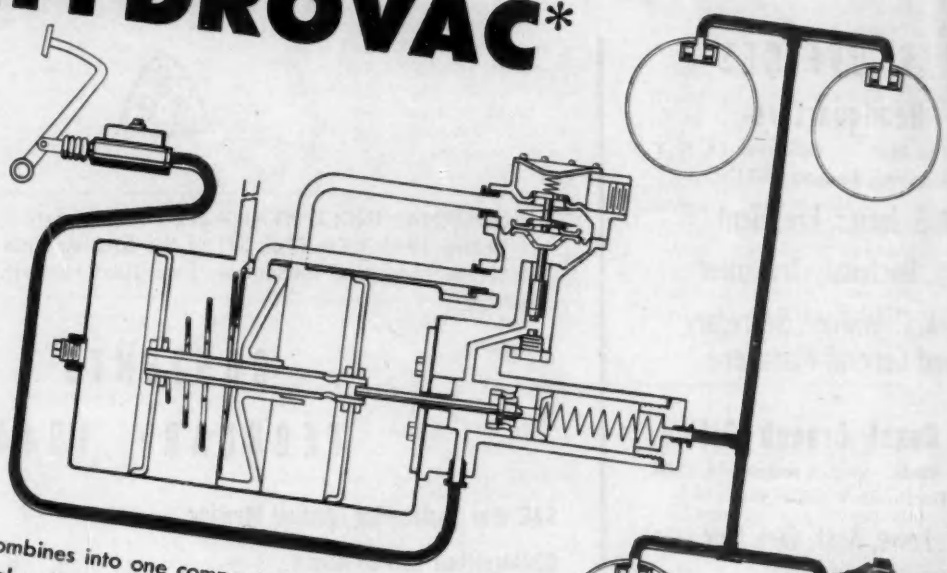
SAE Coming Events 62

a Simpler System

FOR

POST-WAR VACUUM POWER BRAKE

HYDROVAC*



Combines into one compact unit a vacuum control valve, a tandem-piston vacuum power cylinder and a hydraulic cylinder.

NO EXTERNAL LEVERS OR MOVING PARTS

The Hydrovac one-unit vacuum power brake system . . . Physical effort on the brake pedal hydraulically actuates the valve which controls the vacuum power cylinder. The power cylinder acts upon the Hydrovac hydraulic cylinder, providing ample hydraulic power for full brake application.

Easier to install and to maintain . . . a war-proved development for simpler vacuum power braking on postwar vehicles.

BENDIX PRODUCTS DIVISION
South Bend, Indiana

*Trademark of Bendix Aviation Corporation

The Hydrovac now on hundreds of thousands of vehicles, is a product of "The Invisible Crew" of precision equipment which more than Bendix plants are speeding to battle fronts.

THE INVISIBLE CREW
Precision Equipment by
Bendix Aviation Corporation

WAR Engineering-Annual Meeting Marked by Ordnance DS Award to SAE... Future airplane and vehicle design argued

SPARKED by the first Distinguished Service Award given by the U. S. Army Ordnance Department during this war in recognition of "outstanding engineering services in war and peace; in the design, manufacture, and maintenance of Ordnance materiel," the SAE propelled its most dramatic War Engineering-Annual Meeting to spectacular heights of attendance and engineering service at the Book-Cadillac Hotel, Detroit, from Jan. 10 to 14.

With speaker after speaker and committee after committee reporting war-needed data for improving land, air and sea fighting equipment, speculation about possible applications to civilian products was not wanting. Army tests of war vehicles and aircraft, it became plain, already have piled up vast stores of experimental data directly useful to civilian designers and operators; particularly for off-the-road trucks, synthetic tires, aircraft and materials of various kinds.

Popularly blooming fallacies about post-war automobiles, post-war fuels, post-war aircraft developments and other post-war automotive trends were withered with scorching fires of fact by leading technicians of the automobile, petroleum, materials, and aviation industries. Fast developments were pictured in every automotive field, but the phrase "evolution rather than revolution" recurred persistently as the practical engineers looked ahead through the glass of experience. These men who actually will have responsibility for transforming scientific guesses into products for daily use differ from non-technical visionaries chiefly as regards timing. Both see almost limitless advances ahead – but the working engineers are preparing to march steadily toward the horizon of progress. They know that only Superman could reach it in a single standing broad jump.

The relation between immediate war problems and post-war speculations was keynoted by SAE President W. S. James in his inaugural address when he said: "Our motto – like that of the United Nations – has been and is 'Unconditional Surrender' – when we get a war problem we will continue to attack it until it is licked. The war has permanent priority on every SAE agenda until total war is resolved into total victory! . . . My second concern – which bows in importance only to the life-or-death task of winning the war – is to insure by the end of my administration that the SAE is fully equipped with plans and with an integrated program for maximum post-war service both to its members and its industries."

William S. James (left), SAE president for 1944, being congratulated by Mac Short, retiring head of the Society, who passed on to his successor the task of leadership in the SAE's war engineering advisory program, and the administration of the Society's post-war planning

Tuned to that tempo, the meeting brought 48 information-packed papers to the largest individual sessions and the largest total attendance ever recorded at an SAE Annual Meeting. Military highlights, in addition to the award (see pp. 20-21), included the statement by Major-Gen. G. M. Barnes, chief, technical division, Ordnance Department, that "while Germany held the engineering edge at the beginning of the war, she has lost this position"; detailed data about development of the now-famous amphibious "duck," presented by Col. E. S. Van Deusen of T-AC; a vast array of valuable Army test

results on use of synthetic truck tires, given by Lt.-Col. B. J. Lemon and Capt. J. J. Robson of T-AC; additional Army experimental data on tire and track flotation of military vehicles, brought from Camp Seeley by Lt.-Col. J. E. Engler of the Desert Training Command; a forward-looking picture of diesel design trends developed from war experience by E. C. Magdeburger, Bureau of Ships, Navy Department; and an up-to-the-minute presentation of transoceanic air cargo material by Lt.-Com. Neil MacCoull, U. S. Naval Air Station, Lakehurst, N. J.

War Engineering Dinner

The member-only War Engineering Dinner on Wednesday evening saw the largest crowd ever assembled at a similar function on hand to hear Gen. Barnes tell of "Lessons Learned from Captured Automotive Materiel"; to listen to 1943 President Mac Short review the Society's progress during the past year; and to learn from 1944 President W. S. James his hopes and plans for the coming year.

Past-President A. T. Colwell was toastmaster at the dinner, which opened with a welcome to the Annual Meeting from Detroit Section Chairman A. G. Herreshoff, and which included presentation by Gen. Barnes representing the Chief of Ordnance of the citation to the SAE for its outstanding war work.

Mr. Colwell briefly reviewed the SAE's war effort, concluding: "There has been *one* great secret weapon in this War – American industrial production. American industry did not expand – it *exploded*. The great automobile industry merged into the Automotive Council for War Production, and it is fitting that we have members of the Board of Directors with us at this War Engineering Meeting. They are our own family, and have assisted us in every way, including financially, through our war chest. We have appreciated their support and the opportunity extended to us."

From the store of more than 4000 tons of captured enemy equipment, a total of 1500 items, Gen. Barnes drew a clear-cut summary of German and Japanese weapons. "It is our ambition to know enemy equipment so thoroughly that should the Germans change the firing pin of one of their many fuses, we will know that the change has been made and the reasons for this modification," he said.

Study of Japanese weapons shows that the land of the rising sun is not in the big league of ordnance engineering.

Dramatic was the General's display of enemy small arms. A squad of soldiers, first in captured Japanese, and later in German uniforms, explained in turn the weights, calibers, ranges and other details of enemy weapons.

Lesson No. 1 the nation should learn, Gen. Barnes emphasized, is the need for continued cooperation of Army and industry engineers in developing better weapons, the components of which should be standardized in the interest of rapid production and ease of maintenance.

Gen. Barnes' paper, with illustrations, will appear in full in the March issue of the SAE Journal.

Engineering Cooperation Historic Success

President Short, at the dinner, reviewed the SAE's role in the war effort, pointing out how effective has been the "unity of operation" of the program. He said, "Today a dynamically balanced unity exists among our members, our activities and most especially among the vital committees whose projects make up the SAE war program."

But, he said, *time* is the issue. "Time to our soldiers is a sort of bonus that no bank can cash, nor government can vote. Each day that the soldier is out there fighting lessens his chance of survival," he concluded.

Post-War Plans

Stressing that his first concern will be to expedite the Society's war assignments, 1944 President W. S. James, chief engineer, Studebaker Corp., urged that "bold, effective planning begun immediately is essential if we, as a Society, are to be ready in time to meet our post-war responsibilities."

Developing specific ideas for implementation of such planning, President James said in part:

"I would like to see the SAE's post-war planning move along three broad fronts. First, I would like to see a comprehensive, penetrating analysis aimed at defining, as well as possible in general terms, just what can and should be the Society's JOB in the post-war period.

"What scope should our activities cover? What changes are necessary to make our operations even more effective in post-war peace than they were in pre-war peace? That analysis, it seems to me, might start with a reexamination of the job of the Society as a whole and then it might well be carried through our main functional divisions.

"Second, I would like to see a review made of our Society POLICIES and PROCEDURES along both technical and administrative fronts. Are there modifications needed? Should some old procedures be scrapped? Should

J. M. Crawford, chairman, Engineering Policy Committee, Central Aircraft Council, who also is active in the SAE War Program, with Brig.-Gen. John Kay Christmas, assistant to the Commanding General, Ordnance-Detroit, formerly the Tank-Automotive Center

L. P. Buckendale, left, who, representing the Truck & Bus Activity, invited Major-Gen. G. M. Barnes, center, to address the Society, and Past-President A. T. Colwell, toastmaster at the Annual Meeting Dinner Jan. 12

some new ones be considered? Possibly such an examination would result only in minor modifications, but I feel strongly the desirability of making such reexamination at this time.

"Third, I'd like to see a similar examination made of the organizational set-up of the Society. Having defined the job and having clarified the policies and procedures necessary to stimulate a vigorous doing of the job, then I would like to see the organization structure – that is, the tools with which the job must be done – studied carefully.

"I haven't any idea that radical changes are desirable or necessary, because I think that both our pre-war job and our war job have repeatedly revealed the essential soundness and effectiveness of our SAE organization set-up; but I would like to see a reexamination made with the idea of sharpening those organization tools so that they may cut more accurately and more efficiently in carving out the Society's post-war destinies.

"We must be sure that parts of the tooling set-up are not partially or wholly obsolete. We must be sure that the points of our drills are not dull, that the edges of our cutters have not become jagged with use throughout the years. The SAE needs sharp precision instruments with which to do the job that lies ahead.

"Already, under President Short's leadership, the foundation for such intelligent reexamination has been made. At his suggestion, your Council last October (at the first meeting ever held by an SAE Council on the Pacific Coast) set up a Post-War Advisory Committee consisting of seven past-presidents of the Society, men whose knowledge of the Society's workings and objectives is equaled only by their intimate touch with the realities of the industries in which Society members work and in whose service the Society must continue to function. Past-President A. T. Colwell is chairman of this group.

"To this Committee in particular and to the Society as a whole, I take this opportunity of pledging the fullest cooperation and support of every administrative branch in this vital task of preparing the Society for the same important part in winning the peace that it has so dramatically played in the process of winning the war."

Nation Not Adjusted Says War Correspondent

A startling eye-witness account of battle scenes – of the men who use the war equipment designed and built in American factories – was exploded before the Society at the Junior Student Session on the opening evening of the meeting. Robert Sherrod, war correspondent of "Time," who landed with the first Marines ashore at Tarawa, told the story.

The nation, and hence our soldiers and sailors, have not been conditioned to war, because for 20 years America has insisted upon "looking the other way." All the bombing and shelling we can do in the Pacific, he said, cannot win the war. "There is no substitute for the sheer courage of the individual foot-soldier essential to victory."

The war in the Pacific will last a full two years after our victory in Europe, he believes.

Our soldiers on the fighting line are so angry with American civilian attitude, with American labor union activities, and with greedy, lobbying pressure groups that returning soldiers and sailors are likely to become the major problem of all American history, he said.

Business Session

Three events of importance marked the Business Session of the Society held Tuesday evening, Jan. 11.

Announcement was made of the appointment by the SAE Council of B. B. Bachman as Treasurer of the Society to fill, until the next election, the vacancy caused by the death of Treasurer David Beecroft.

The proposed amendment to the SAE Constitution which would change the name "The Society of Automotive Engineers, Inc." to "The Society of Automotive and Aeronautical Engineers, Inc." was referred to the SAE Post-War Advisory Committee for further study.

Life membership in the Society was conferred upon Past-President A. T. Colwell.

Following pages summarize some of the more outstanding ideas, trends, and developments revealed throughout the various sessions. So great was the scope and value of the information presented, that many pages in later issues will be required to bring to readers adequate digests of the 48 technical papers.

In later issues every paper presented at this War Engineering-Annual Meeting will be presented either in full in our Transactions Section or as digests.

Every MEMBER of the SOCIETY

Major-Gen. G. M. Barnes (right), representing the chief of Ordnance, presents the Ordnance Distinguished Service Award to the SAE. Receiving the Award in the name of the Society are SAE 1943 President Mac Short (center) and B. B. Bachman (left) chairman, SAE War Activity Council. Gen. Barnes was one of signers of the Award

James C. Zeder (left), chairman, SAE War Engineering Board, with Major-Gen. G. M. Barnes and Col. H. W. Alden, chairman, SAE Ordnance Advisory Committee. Work of the W.E.B. and its many subcommittees contributed heavily to the program resulting in presentation of the Distinguished Service Award to the Society. The OAC has served the Ordnance Department continuously since 1918

ETY SHARES this HONOR.....

A
FACSIMILE REPRODUCTION
of the
DISTINGUISHED SERVICE AWARD
received from the Ordnance Department
WILL GO TO EVERY SAE MEMBER
as part of the
MARCH SAE JOURNAL
Watch for your copy!

THE ORDNANCE DISTINGUISHED SERVICE AWARD has been presented to the Society of Automotive Engineers.

First award of its type to be made by Ordnance to any engineering society, it cites the SAE for

"Outstanding and Meritorious Engineering Advisory Services in War and Peace: In Design, Manufacture, and Maintenance of Ordnance Materiel."

Presentation of the Award was made by Major-Gen. G. M. Barnes, chief, technical branch, Ordnance Department, in the name of the Chief of Ordnance at the SAE War Engineering-Annual Dinner on Jan. 12, 1944, in Detroit.

Making the presentation, Gen. Barnes stressed the SAE's assistance to Ordnance prior to World War II, the vast expansion of its facilities for direct aid since the start of the present emergency and urged continuance "in this important work of helping the Ordnance Department throughout the duration of war . . . and also in the post-war period."

"EVERY MEMBER OF THE SOCIETY shares this honor which has come to us," President Mac Short assured Gen. Barnes in accepting the Award, adding that "the responsibility for continued service stands out clearly in the mind of every SAE member.

Expressing concretely that feeling of responsibility, the members assembled approved unanimously by rising vote the following resolution proposed by President Short:

"The Society of Automotive Engineers pledges to the Ordnance Department continued acceleration of its technical advisory service throughout the existing emergency;

"FURTHER: it pledges for the post-war period establishment of permanent machinery to make possible uninterrupted peacetime service to the Army and Navy to the end that the facilities of our organization may constantly be utilized in the never-ending task of guarding American liberties and the American way of life."

Supplementing President Short's acceptance remarks, War Engineering Board Chairman James C. Zeder stressed

turn to p. 49

Donald K. Wilson (left) chairman, SAE Ordnance Vehicle Maintenance Committee; Brig.-Gen. Julian S. Hatcher, chief, Field Service Division, Ordnance Department; Lt.-Col. Harry O. Mathews, Office of Chief of Ordnance, Detroit; and Jean Y. Ray, chairman, SAE T&M War Advisory Committee. Lt.-Col. Mathews is liaison for Gen. Hatcher with the work of the SAE-OVMC, whose important activities are among those recognized by the Distinguished Service Award. Gen Hatcher was one of the five signers of the Award

News of the Society

SAE Air Transport Activity is Formed

Organization of an Air Transport Engineering Activity, in answer to requests from a large number of key operators in the air transport field, was approved by the SAE Council at its Jan. 14 meeting.

This new, and eleventh, professional engineering activity of the Society will be similar in organization to the present SAE Aircraft Activity, the SAE Aircraft-Engine Activity and the other SAE Professional Activity groups.

The Council is now in process of appointing a chairman and members of an Activity Committee for the new Air Transport group, in accordance with the provisions of the SAE Constitution. This committee and its chairman will (1) actually serve as the Air Transport Activity Committee during 1944 and (2) will nominate seven members of an Air Transport Activity Nominating Committee whose function it will be to nominate a vice-president of the Society representing Air Transport Engineering for 1945.

SAE Treasurer's Report

by B. B. BACHMAN,
Treasurer, Society of Automotive Engineers, Inc.

FOR ten years Mr. David Beecroft served as Treasurer of the Society, and it was with deepest regret that we learned of his death this last November.

During the past fiscal year, ending Sept. 30, 1943, the Society was particularly active on various war engineering fronts, as you will see from the reports of other Society activities. Fortunately, additional revenues from dues and advertising have helped to offset the greatly increased expenditures because of our contribution to the war effort. Last year, you will recall, the Society received contributions to a War Chest fund and used only such portions of this fund as Council deemed necessary to cover a reasonable part of our war expenditures. The same policy has been continued during the current year.

The Comparative Balance Sheet and Income and Expense Statement, which are a part of this report, show in brief:

	1942-43	1941-42
Income	$477,367.23	$380,451.42
Expense	488,837.11	402,923.97
Net Unexpended Income	$11,469.88*	$22,472.55*

*Deficit

The Society's investment portfolio was increased by $15,112.50 during the past fiscal year. At the close of the year the total book value of securities held was $271,629.76, and their actual market value on the same date was $271,700.00. These securities, all bonds, are distributed as follows: U. S. Government, 44%; Public Utilities, 26%; Industrials, 23%; and Railroads, 7%.

As is customary each year, the books of account have been audited by Haskins and Sells.

BALANCE SHEET
As of Sept. 30, 1943

ASSETS	
Cash	$80,779.78
Cash—Restricted	9,954.69
Cash—SAE War Chest	67,101.23
Accounts Receivable	7,972.85
Securities	271,629.76*
Accrued Interest on Securities	2,526.46
Inventories	649.70
Furniture and Fixtures	1,000.00
Deferred Charges	9,961.30
Appropriations Receivable	.....
Total Assets	$431,575.57
LIABILITIES AND RESERVES	
Accounts Payable	$19,110.73
National Dues and Miscellaneous Items Received in Advance	12,644.08
Reserve for Restricted Funds	9,354.69
Reserve for Appropriations Unearned	.....
SAE War Chest	62,966.29
General Reserve	328,499.78
Total Liabilities and Reserves	$431,575.57
* Book Value—(Market Value—9/30/43	$271,710.00)

During 1942-43 a total of $93,812.16 was transferred from the SAE War Chest to General Reserve.

Income and Expense and Budget Comparison
12 Months, Ending Sept. 30, 1943

Oct. 1 to Sept. 30	1942/1943	1942/1943 Budget	1941/1942
INCOME			
Dues and Subscriptions	$123,529.09	$110,000.00	$106,540.15
Initiation Fees	37,382.50	17,000.00	21,132.50
Interest and Discount	7,757.35	8,200.00	8,416.11
Affiliated Appropriations	1,229.17	.....	34,624.99
Advertising—Journal	221,451.75	140,000.00	142,453.25
Advertising—Handbook	14,050.00	10,000.00	10,250.00
Miscellaneous Sales	68,966.37	45,000.00	52,880.17
Unused Portion of Section Dues	3,001.00	.....	4,154.25
Total Income	$477,367.23	$330,200.00	$380,451.42
EXPENSES			
Research	$1,951.56	$1,286.00	$11,937.96
Coordinating Research Council	27,625.00	25,000.00	9,041.67
Standards	47,249.76	39,782.00	35,147.79
Publications	81,194.89	74,694.00	71,479.53
Sections	8,927.87	8,450.00	7,814.13
Membership	19,048.34	16,520.00	16,342.98
Meetings	22,786.13	23,095.00	20,459.98
Advertising—Journal	69,832.85	44,205.00	44,401.62
Advertising—Handbook	2,945.04	2,150.00	2,145.31
Miscellaneous Sales	40,812.48	25,704.00	30,114.82
Miscellaneous Government Cooperation	19,887.60	19,774.00	12,098.45
Detroit Office	14,343.84	12,300.00	6,993.99
Professional Activities	10,529.24	9,360.00	7,789.08
West Coast Branch Office	11,582.85	11,490.00	10,948.89
General Expense	109,439.57	103,935.00	103,012.86
Loss on Sales of Securities	880.09	.....	5,665.98
Engineering Relations	.....	.....	7,534.26
Total Expenses	$488,837.11	$417,855.00	$402,923.97
Net Unexpended Income	11,469.88**	87,655.00**	22,472.55**

**Deficit

Joint Session Discusses High Pressure Hydraulics

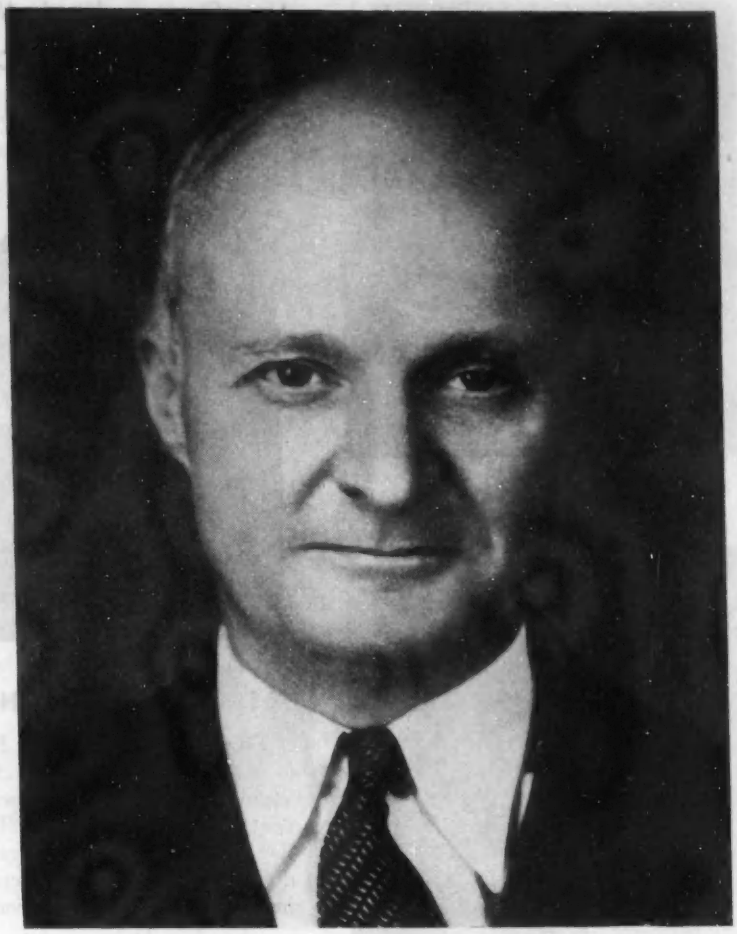
DURING the recent four-day meeting of the National Aircraft Standards Committee and Committee A-6, Aircraft Hydraulic Equipment, of the SAE Aircraft Accessories & Equipment Subdivision, in Chicago, the Army and Navy representatives asked the committee to continue its standardization work in the field of the 3000 psi airplane hydraulic equipment.

Furthermore, manufacturers of this equipment and airplane manufacturers were asked to keep the committee informed on all design and servicing developments.

Total attendance reached 157. Greatest interest was focused on the 3000 psi systems. On Nov. 29 and 30 the two committees were in joint session, and on Dec. 1 and 2 industry, Army and Navy representatives joined the conference.

Harry Kupiec, Glenn L. Martin Co., was chairman of the sessions. Harold Adams, Douglas Aircraft Co., is chairman of the SAE Committee A-6.

1944 PRESIDENT



WILLIAM STUBBS JAMES

William Stubbs James, president of the Society of Automotive Engineers, did his first direct work in automotive engineering during World War I when he was placed in charge of an altitude laboratory at the Bureau of Standards in which aviation fuel specifications were being investigated. In 1918 he joined the SAE.

He had been uncertain about what kind of an engineer he wanted to be when, back in 1911, he matriculated in night school at George Washington University after landing a job with the Bureau. But he was impressed by the future dependenec of civilization on mechanical power. The romance of water power fascinated him for a while.

"Then one day I figured out the potential of all the water power in the world," he says. "I found it would amount to only a small percentage of the power possible through utilization of coal and oil. It seemed like spitting in the ocean. So I lost interest in the subject."

A Bureau assignment on refrigerating constants switched him for a time to chemical engineering. Later another professional project got him absorbed in mechanical engineering. His studies in constants led him into mechanical refrigeration.

But once into automotive work, he stayed there. By 1924, he had served several years as head of the automotive powerplant section of the heat division of the Bureau. Then he entered private industry – as an engineer for Hupp Motor Car Co.

"The same year," he says, "I was offered a job with the Associated Oil Co. of California. . . . Somehow my family has always been gravitating to California."

At Associated, Bill James plunged into a pioneering development of fuels from West Coast crude. He was directed to construct fractionating towers of hitherto untried size, although he had never previously seen such equipment. Because of the volume of oil to be processed, he decided to install a marine steam oil burner under the still instead of a more conventional gas pipe heater. Refinery experts predicted the plant would be blown into the bay. He overcame this danger by introducing a centrifugal pump to circulate oil in the still.

Bill James quit the oil industry, he explains, "because at that time it was easier to find another barrel of oil than to refine the one on hand twice as well." He joined Studebaker in 1926 as chief research engineer.

A scientist by inclination and training, he wants to remain an integral part of research and development engineering. He has an insatiable appetite for hard facts and an amazingly retentive memory. His office is located in the center of an unimposing row of cubicles on the second floor of Studebaker's engineering building. "If I got stuck in richer surroundings," he reasons, "maybe nobody would come in and tell me what's going on."

Because he is readily accessible, Bill James' business day consists largely of solving the problems of others. That means lots of home work on his own. It also means wide, practical contact with every conceivable kind of automotive problem day in and day out.

Bill James is recognized throughout the industry as an authoritative voice on many phases of automotive engineering. His papers before the SAE and other technical groups have ranged from lubricants to axles – and from engines to transmissions and tires. His participation in SAE technical activities has been as wide as the range of his papers – and he has served the Society broadly in administrative posts as a vice-president, as a Councilor and as a leader of engineering groups.

Bill James has few social activities outside his professional sphere. His golf is about the average SAE standard. One "enlightening period" he spent as a member of the South Bend City Council. "It taught me the interest the politician takes in his job and the lack of interest the citizen takes in his," he reminisces. "It convinced me we don't have to worry about national administrations if we clean up local governments. Washington is just a reflection of city and state governments."

Bill James was born in Asbury Park, N. J., on Sept. 3, 1892. His parents on both sides had English ancestry. His father, Dr. Joseph Francis James, a botanist and physician, died when James was four. His mother engaged in Government work and shifted frequently about the country. This accounted for an educational background in various cities and schools. He graduated from grade school in Washington, D. C., and from high school in Berkeley, Calif.

Mac Short, Lockheed Aircraft Corp., president of SAE for 1943, takes his place on the 1944 Council as past-president.

MAC SHORT

BENJAMIN B. BACHMAN

Treasurer Benjamin B. Bachman (LM '10), vice-president in charge of engineering, Autocar Co., was president of the SAE in 1922. He joined the Autocar engineering organization during the industry's pioneering days in 1905, after earlier experience with several Philadelphia manufacturing companies and with the Frankford Arsenal. During Autocar's passenger car and early truck-building era, he was promoted through various positions to become assistant chief engineer in 1909. In 1914, he was advanced to chief engineer – and in 1929 was elected vice-president in charge of engineering.

Mr. Bachman has been a dominant force in SAE technical and administrative work both before and after serving as president. Currently he is chairman of the SAE War Activity Council, under whose direction the entire SAE War Program is coordinated. He is also president of the board of directors of the Cooperative Research Council, Inc.; is an active member of the War Engineering Board; and – until his selection as treasurer – for several years has been chairman of the Finance Committee.

During World War I, Mr. Bachman was active in military truck phases of the Society's work for the War Department and has long been a member of the Ordnance Advisory Committee.

A. W. Herrington, 1942 president of SAE, continues on the Council as past-president.

A. W. HERRINGTON

L. RAY BUCKENDALE

Councilor L. Ray Buckendale (M '19) is vice-president in charge of engineering at Timken-Detroit Axle Co. Starting with the company as a draftsman while still a student at the University of Michigan, his 32-year record there has been interrupted only by a period of military service in the first World War.

Long active in SAE affairs, Mr. Buckendale plays a prominent part in the Society's war program at the present time. He is a member of the SAE War Engineering Board and sponsor of several of its most important subcommittees. He has been associated with the SAE Ordnance Advisory committee for many years, and is chairman of its Transmission Committee. Mr. Buckendale is a former SAE vice-president representing Truck & Bus Engineering, is a member of the SAE Motor Truck Rating Committee, and is chairman of the Axle & Wheel Division of the SAE Standards Committee.

He was a captain in the Ordnance Department during World War I.

★ ★ ★

HAROLD T. YOUNGREN

Councilor Harold T. Youngren (M '12), chief engineer of the Oldsmobile Division, General Motors Corp., displayed his interest in engineering shortly after graduating from high school, when he became a drafts-

★ COUNCILORS ★

C. G. A. ROSEN

N. P. PETERSEN

Continuing on the SAE Council are N. P. Petersen, president and general manager, Canadian Acme Screw and Gear, Ltd.; C. G. A. Rosen, director of research, Caterpillar Tractor Co.; and Arthur Nutt, vice-president of engineering, Wright Aeronautical Corp. Mr. Nutt was elected to fill the 1943-1944 term of James C. Zeder, resigned.

ARTHUR NUTT

man for Allis-Chalmers Mfg. Co. From that time until World War I he was on the engineering staffs of Westinghouse, Falls Motor Co. and Harley-Davidson Motor Co.

Aiding in the design of the Fergus automobile, the development of the Houdaille shock absorber, and the design of the Pierce-Arrow chassis and engine, Mr. Youngren specialized in this type of work until 1927, when he went to Studebaker Corp. as a consulting engineer. After being promoted to executive engineer in charge of passenger car chassis design, he joined General Motors as assistant chief engineer for Buick, and in 1933 assumed his present position.

Mr. Youngren served as an officer of both the Buffalo and Detroit Sections of the SAE.

ROBERT F. STEENECK

Councilor Robert F. Steeneck (M '30), Cleveland district manager of Fafnir Bearing Co., has been engaged for many years in the development and design of ball bearings for automotive, aircraft and industrial applications. He was a representative of John Warren Watson Co. before joining Fafnir as West Coast field engineer in 1928.

One of the Society's "cosmopolitans," in his present capacity Mr. Steeneck has been affiliated with the Northwest, Northern California, Metropolitan and Detroit Sections, as well as with the Cleveland Section, of the SAE. He was chairman of the National Membership Committee in 1941-1942, and has been a member of the governing board of the Cleveland Section for the past four years.

Mr. Steeneck was born and educated in Detroit.

★ ★ ★

★ ★ ★ VICE

RAYMOND D. KELLY (M '29), vice-president, Aircraft Activity, and superintendent of development, United Air Lines Transport Corp., decided upon aviation as a career when he took his first flight in an airplane while still attending Franklin College, Indiana. This led him to study mechanical engineering at Purdue University, where he graduated with a B.S.M.E. degree.

Contributing to the development of the electrically-heated pitot tube now generally used, and to an altimeter for maintaining level flight in aerial photographic work, Mr. Kelly was placed in charge of Boeing Air Transport Corp.'s instrument shop at their Cheyenne base in 1930. When this company became a part of United Air Lines in 1936, he went to Chicago as test engineer, and shortly thereafter was made head of the company's Engineering Development Group.

Mr. Kelly has been engaged in war operational activities as well as research relating to economic aspects of future airplane designs.

★ ★ ★

ALBERT J. BLACKWOOD (M '27), vice-president Diesel-Engine Activity joined Standard Oil Development Co. in 1927. He is now research engineer at Esso Laboratories. For several years past he has been responsible for engine testing and laboratory development work on automotive, diesel and aviation fuels. Prior to this he had spent three years as instructor of experimental engineering at Cornell, where he received his degree in mechanical engineering, and two years in the experimental and testing laboratory of Mack-International Motor Co.

He has been sole or co-author of over a dozen technical papers on subjects relating to the properties and operating performance of fuels and lubricants, eight of which have been presented before the Society.

Mr. Blackwood was vice-chairman of the Diesel-Engine Activity in 1942, and is a member of the Tractor and Farm Machinery Activity Committee.

★ ★ ★

OTTO R. SCHOENROCK (M '11), vice-president, Tractor & Farm Machinery Activity is chief engineer of J. I. Case Co., and has been in the tractor and farm machinery field for many years. He had been director of engineering for Oliver Farm Equipment Co., and chief engineer of the Gas Power Engineering Department, International Harvester Co.

From 1910-1917, he was in the automotive field as chief engineer and superintendent of Lincoln Motor Car Co., Harder Auto Truck Co. and Woods Electric Vehicle Co.

A graduate from Lewis Institute of Chicago, where he majored in mechanical and electrical engineering, he has been both secretary and chairman of the Chicago Section, and is serving on the ASA Sectional Committee (B 29) on Roller Transmission Chains, Sprockets and Cutters. He is also a member of the Society of Military Engineers.

PRESIDENTS ★

E. M. SCHULTHEIS (M '16), vice-president, Truck & Bus, started in the automotive industry in 1908. He is now Detroit manager of the Clark Equipment Co.

His early experience was gained in the engineering departments of F. W. Spacke Machine Co., the Pope-Waverly Co., Cole Motor Car Co. and the Premier Motor Corp. Post-war years found him with the Aluminum Co. of America, White Motor Co. and Timken Roller Bearing Co.

Mr. Schultheis has been engaged in SAE technical and administrative committee work for the past 20 years, serving as a member of the board of the Detroit Section, a member of the Motor Truck Rating Committee, and a representative of the Production and Truck & Bus Activities.

★ ★ ★

EARL H. SMITH (M '20), vice-president, Passenger-Car Activity, and executive engineer of Packard Motor Car Co., now holds for the second time the same SAE vice-presidency in which he served seven years ago. Long active in SAE work, he is a member of the War Engineering Board. He has been a member of the Front Wheel Alignment Subcommittee, vice-chairman of passenger cars of the Detroit Section, and is chairman of the Publication Committee.

Graduating with an engineering degree from Armour Institute of Technology in 1917, Mr. Smith entered the Army, and served until 1919. Since then he has devoted his time to automotive engineering, and before joining Packard in 1934, was assistant chief engineer at Pontiac.

★ ★ ★

JOHN E. HACKER (M '31), vice-president, Production Activity, received his early experience with Winton Motor Car Co. and Winton Engine Works. He left Winton to serve in the United States Army Ordnance Department Bureau of Engineering on tank and tractor design and construction during World War I.

He joined the White Motor Co. in 1920, and as production manager returned to Winton Engine, which later became Cleveland Diesel Engine Division of General Motors Corp. He holds the same position at present.

★ ★ ★

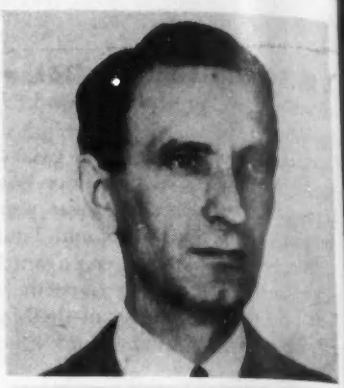
ALFRED THORNE GREGORY (M '35), vice-president, Aircraft-Engine Activity, is chief engineer of Ranger Aircraft Engines Division of Fairchild Engine & Airplane Corp.

He had nine years of practical experience in the aircraft field, starting as a clerk in the Wright-Martin plant, later becoming successively machinist, toolmaker and draftsman for Wright Aeronautical Corp., before entering Stevens Institute of Technology in 1926. His work there won him a three year fellowship to study diesel engines in Germany, and in 1933 he received his doctorate in engineering at Munich.

Returning to Wright Aeronautical as test engineer, Mr. Gregory left that company in 1935 to become research engineer at Ranger, and two years later assumed his present position.

He was vice-chairman of aeronautics of the Metropolitan Section in 1939.

★ VICE PRESIDENTS ★



JOHN R. SABINA (M '35), vice-president, Fuels & Lubricants Activity, first came directly in contact with fuels and lubricants problems in the automotive laboratory of the Atlantic Refining Co., where he worked on an electrical method for determining fuel detonation tendencies. He transferred to his present position at E. I. du Pont de Nemours & Co. in 1937 as manager of the Petroleum Chemicals Testing Laboratory, which was formed to investigate the applicability of chemicals to petroleum products.

After his graduation from the University of Pennsylvania in 1923, he became test engineer of Baldwin Locomotive Works, later joining Atlantic Refining Co. in the same capacity.

Mr. Sabina has taken part in SAE cooperative projects starting with the early CFR committee work on detonation, leading to the first Uniontown road tests in which he participated. Subsequent activity has been in the fields of motor, aviation and diesel fuels and lubricants under SAE and CRC sponsorship. His technical papers and co-authorship of reports have been important additions to this field of engineering.

★ ★ ★

EDGARD C. DE SMET (M '21), vice-president, Passenger-Car-Body Activity, joined Willys-Overland Motors, Inc., in 1936 as chief body engineer. At present he holds the position of executive engineer in charge of post-war engineering activities and is also serving as chief engineer of the Aircraft Division.

He learned the automobile body business, his specialty, by active contact with the Van den Plas Co., leading European coach builders. Successively, he was body draftsman and designer for Locomobile Co. of America, Dodge Bros., Handley-Knight Co. and Briggs Mfg. Co. Later he was body designing engineer for Hudson Motor Car Co. and Chrysler Corp.

Considered an outstanding authority on surface layout and design, Mr. De Smet outlined the principles governing this work in technical papers presented at the 1934 and 1935 SAE Annual Meetings.

He received a mechanical engineering degree from the University of Ghent in Belgium, his native country.

★ ★ ★

ELLIS W. TEMPLIN (M '18), vice-president, Transportation & Maintenance Activity, is automotive fleet engineer of the Bureau of Power & Light of the City of Los Angeles, where he directs the engineering work related to the operation and maintenance of a fleet of 1200 units. In World War I, as assistant chief engineer of the Selden Motor Vehicle Co., he built the first Class B standardized military truck in 20 days, and later put that model into quantity production.

During his career in truck design, manufacture, and fleet operation, Mr. Templin carried out the idea of the six-wheel truck as an aid to the successful employment of pneumatic truck tires when at Goodyear Tire & Rubber Co., and later designed many types of city, inter-city and double deck buses for the Six Wheel Co. Shortly after he was made superintendent of interplant transportation at Chrysler Corp.

Mr. Templin, a graduate of Purdue University, has been a member of the SAE Council, chairman of the Philadelphia and Southern California Sections, and is now project chairman of the SAE-ODT T&M Committees 6, 8, 11, 16 and 30.

COOLING-SYSTEM MAINTENANCE

(Including Cleaning, Flushing, Rust Prevention, and Antifreeze)

PART II

Completed herewith is the report of the Subcommittee on Cooling-System Maintenance of the SAE Maintenance Methods Coordinating Committee of the SAE Transportation and Maintenance Activity prepared for the Office of Defense Transportation.

Part I, which appeared in the January issue, covered the routine inspection and maintenance of the cooling system to prevent liquid losses and to keep the system in proper working order at all times, along with an outline for the quick diagnosis of overheating and overcooling. Part II concludes with a discussion of the prevention of corrosion, methods of cleaning clogged systems, and properties of common antifreeze solutions.

E. Corrosion and Its Prevention

Rust-proofing of the cooling system in winter can be accomplished automatically through the use of standard antifreeze products containing corrosion-preventing ingredients called inhibitors. However, judging from the limited use of corrosion inhibitors with water, it is apparent that many vehicle operators do not fully appreciate that the corrosion problem is even more serious in warm weather because of higher operating temperatures and aeration rates prevailing with the thermostat valve wide open and with maximum liquid flow and turbulence in the radiator.

The discussion of cooling-system corrosion which follows is based on tests in laboratory corrosion apparatus, engine dynamometers, and vehicle driving service. Since water is the standard cooling liquid around which most automotive engines are designed, a review of the corrosive effects of normal and incidental contaminants in water should give the vehicle operator a better understanding of the need for rust-prevention treatment.

The common water contaminants causing corrosion of cooling system metals are oxygen from the air, dissolved minerals in natural water supplies, acids from exhaust gas leakage into the system, residual chemicals in the water jacket or radiator, undrained and unneutralized cleaning solution, inorganic salt antifreezes, and some stop-leak preparations. Corrosion is also a function of the composition, location, and proximity of various cooling-system metals. Electrolytic corrosion is stimulated by combinations of different metals in contact with each other, as in alloys, soldered, and brazed joints, metal gasket joints, and imperfect lead or copper plating on thin steel parts.

E-1. Aeration of the Cooling Liquid – No cooling system is free of air, and oxygen from the air is the most prevalent and serious factor in promoting corrosion in any type of water. For example, in typical water supplies, such as the Great Lakes, aeration of water can increase corrosion of iron 30 times. In more corrosive mineral waters, the effects of aeration may be more severe. Even in distilled water, the effects of aeration on corrosion are marked, especially with iron and solder. Since air entrainment and aeration of the cooling liquid take place during engine operation and usually increase with engine speed, the corrosive effects of oxidation are relatively greater as vehicles are driven more miles and at higher speeds.

Even in leaktight cooling systems, entrained air during normal engine operation may exceed 1% of the total volume of the cooling system. There are two principal causes of aeration in a leaktight system. Turbulence of the cooling liquid in the top tank of the radiator produces air entrainment which increases as the liquid level drops. In addition, when the level drops to or below the top of the water tubes, pump suction becomes a serious problem in that air in large quantities is drawn in through the radiator overflow pipe and down through the water tubes.

E-2. Mineral Salts in Natural Water Supplies – The corrosiveness or noncorrosiveness of natural waters in cooling-system service cannot be accurately predicted in any particular case from analysis of the water. Various mineral salts occurring in the water may have a neutralizing action on one another or they may all increase corrosion. Neither can any particular interpretation regarding corrosion be placed on the total dissolved solids found. Furthermore, even in ground- or well-water supplies the mineral salt content varies somewhat with rainfall, while in surface waters, as from lakes and rivers, the variation in mineral content is even greater. It has been estimated that the usage of well and surface waters is about equally divided on the basis of population, the smaller communities and rural districts being supplied principally with well water of higher mineral salt content.

The common mineral salts found in natural waters and which stimulate corrosion are chlorides and sulfates in combination with calcium, magnesium, and sodium. Chlorides are by far the most active and as little as 200 parts per million are quite likely to stimulate corrosion. The effect of either sulfates or chlorides or mixtures of both is generally characterized by local pitting and sometimes perforation of metal parts, although metal weight losses may be comparatively low. The degree of attack on different metals is erratic and unpredictable. Several deep-well waters were found to contain from 200 to 500 parts per million of chlorides or chlorides plus sulfates. High-saline well waters are difficult to inhibit in comparison with surface waters and inhibition is not as effective as in waters relatively free of mineral salts.

The average sulfate and chloride contents of 12 large surface-water supplies located across the country were 38 parts per million and 13 parts per million, respectively, and the average hardness 103 parts per million. In general, it appears that surface waters containing up to 170 parts per million hardness, 90 parts per million sulfate, or 45 parts per million chloride will have similar corrosion characteristics in the cooling system. Apparently, chloride and

sulfate content in the range of 10 to 100 parts per million will not greatly influence corrosion.

In surface waters, the average corrosion weight loss of nonferrous cooling-system metals (aluminum, brass, copper, and solder) was only 2% that of iron, and in saline well waters 10%, the latter due to the increase in nonferrous loss and decrease in iron loss with high-saline content. However, the danger of embrittlement, pit corrosion, and perforation should not be minimized in nonferrous metals because of the low weight losses.

Acidity in natural waters (pH below 7.0) accelerates iron corrosion and rust formation, while alkalinity reduces attack on iron. Decomposition of vegetable and animal matter in water will produce acidity. Waste chemical matter from factories or plants may produce either acidity or alkalinity. Aerated distilled water may be as corrosive to brass and more corrosive to iron, copper, and solder than some high-saline waters.

E-3. Incidental Contaminants – 1. Residual zinc-chloride solder flux in the radiator or ammonium chloride sometimes used for sealing porous water jackets can cause serious corrosion in quantities as small as 100 parts per million in the cooling water.

2. Unneutralized acid-cleaner solutions as well as alkaline-cleaner solutions left in the system after use may also accelerate corrosion of various metals. Vehicle operators are cautioned about the use of hydrochloric (muriatic) acid as a cooling-system cleaner because of the high corrosion rate of chlorides.

3. Stop-leaks should be selected with care because of possible organic acid content when installed or the development in service of acidity and possibly corrosion through decomposition of stop-leak ingredients.

4. Exhaust gas leakage into the cooling system contaminates the cooling liquid with various acids which accelerate rust formation and corrosion.

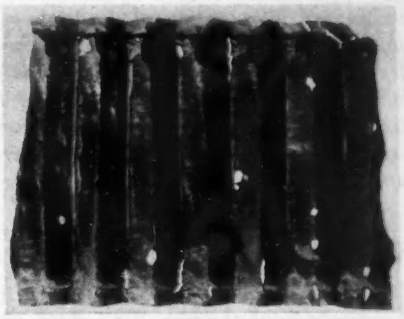
5. The corrosive effects of inorganic salt antifreezes such as calcium and magnesium chlorides are unfortunately well known to a large number of vehicle owners, who unwittingly purchased them as substitutes for safe organic antifreezes.

E-4. Effect of Temperature on Corrosion – With the use of surface waters, the rate of corrosion with iron appears to reach the maximum at cooling-liquid temperatures corresponding to best engine performance. Aluminum seems to be susceptible to the greatest attack at slightly higher cooling-system temperatures. For a temperature rise from 70 to 175 F, the rate of iron, copper, brass, and solder corrosion more than doubles. Laboratory test results indicate that higher engine-operating temperatures during warm-weather driving speed up corrosion and rust formation.

E-5. Typical Corrosion Damage of Cooling-System Parts – Among the cooling-system metal parts commonly damaged from corrosion of the cooling liquid when rust-prevention treatment is neglected are radiator cores and caps, water pumps, cylinder heads, water-jacket cover plates, core-hole plugs, water-distribution tubes, and manifolds. (See Figs. 24, 25, 26, and 27.)

E-6. Treatment of Cooling Water for Corrosion Prevention – A coating of rust in the water tubes of the radiator or on the heated surfaces of the engine inside the water jacket will interfere with heat transfer even when very thin. If cooling of the engine is to be maintained at new-car efficiency, rust deposits must be *prevented* from forming. Likewise, corrosion of iron and other cooling-system metals must be reduced to a minimum if replacement of parts from corrosion damage is to be avoided. Suitable treatment of water for corrosion prevention will reduce rusting of iron at least 95%. Rust inhibitors for water are inexpensive and simple to use, and make cleaning and flushing unnecessary for long periods of driving. Cooling-system rust prevention is strongly recommended by vehicle factories.

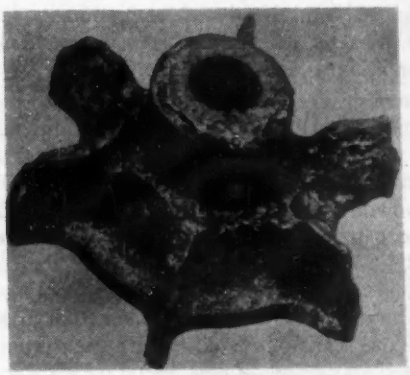
Large fleet operators report reduction of cooling-system rust-clogging and corrosion damage after using corrosion inhibitors with water. One operator states from his experience that treatment of water for rust prevention prolongs the life of the engine and radiator regardless of operating conditions. Another reports that in years of use



■ Fig. 24 – Corrosion of radiator water passage metal

of rust inhibitors in a large fleet only two radiators had to be replaced and both were in accidents.

There are two types of water inhibitors in general use – soluble oils and salts. For best results, each type should always be used in the proportions recommended by their manufacturers. Corrosion inhibitors do not remove rust already formed in the system, and any necessary cleaning out of rust should be performed before the inhibitor is installed. Standard antifreeze products contain corrosion inhibitors and it is, therefore, not necessary or desirable to add extra inhibitor to fresh antifreeze solutions. Mixing



■ Fig. 25 – Water-pump-impeller corrosion

different types of inhibitors in the cooling system and the use of inhibitors that cause foaming and overflow loss should be avoided.

Treatment of water for rust prevention can best be accomplished in the cooling system itself. Starting with the system clean, simply fill it nearly full with fresh water and

add the recommended dosage; then operate the engine until it reaches driving temperature to open the thermostat and establish circulation through radiator and engine block for complete mixing.

Where antifreeze is used, drain the solution in the spring after freezing weather is past; flush the system thoroughly and clean if necessary; then install a fresh filling of summer rust inhibitor and water. If leakage and overflow loss of inhibitor solution are kept down to a minimum, one treatment should be effective for the warm-weather

▪ Fig. 26 – Corroded water-distribution tube, showing irregular corrosion holes

driving season. If antifreeze is not used, add a dosage of rust preventive to a fresh filling of water both spring and fall.

Inhibitor treatment of water prevents corrosion and rust formation by chemical action and by depositing a thin protective film on the inside walls of the cooling system. In a system that was clean originally, the appearance of rust in the radiator or in solution is an indication that the inhibitor is weakened from adding water or is exhausted from use. In either case, the solution should be drained, the system flushed, and a fresh filling installed.

▪ F. Clogging and Methods for Cleaning

Although engine overheating from clogging of the cooling system was found in a recent survey to be the cause

▪ Fig. 27 – Section of aluminum head showing corrosion damage

of over 12% of all cooling-system troubles, this difficulty can be avoided entirely by preventive cleaning and regular rustproofing. Analyses of clogging materials removed from radiators and water jackets show them to be made up mostly of iron rust, water scale, and grease, with iron rust comprising over 90% of the bulk. Grease and oil may enter the system through the water pump and through leaks at the cylinder-head joint or in water-jacketed oil coolers and lines. The amount of rust or other materials that will clog a radiator is much smaller than is generally realized. Enough rust to fill the top quarter-inch of the water tubes will cause serious restriction of water flow.

The rate of corrosive attack of untreated water on iron is invariably higher than on other cooling-system metals. In the average surface-water supply, corrosion weight loss of iron is found to be over 10 times as great as the total weight losses of aluminum, copper, brass, and solder for the same surface area. Considering this fact, as well as the comparatively large iron surface exposed in the water jacket and other parts of the cooling system, it can be readily appreciated why iron rust is the principal problem in the loss of heat transfer and in the clogging of radiators and water jackets. Besides reducing heat transfer and restricting circulation, another deleterious effect of rust is to shorten the noncorrosive life of antifreeze solutions.

The main source of cooling-system rust is the engine water jacket, where the rust is formed on the iron surfaces. Liquid circulation keeps loosening the rust as it forms and the larger rust scales usually settle in the water jacket. However, the finer particles are carried over into the radiator where they become attached to the inside walls of the water tubes and tanks in the form of a hard, adherent scale.

A year or more is usually required for the rust layer in the radiator tubes to become thick enough to restrict circulation seriously, but in the meantime the scale accumulations continue to reduce the cooling efficiency of the radiator until the engine finally overheats. Resultant boiling stirs up the rust deposits which have been growing in the water jacket and circulation carries large quantities over into the radiator. After boiling starts, only a short period of operation is needed to load the radiator tubes and practically stop circulation. Then further driving is out of the question until both the radiator and engine block receive corrective cleaning service. (See Fig. 10.)

F-1. Water-Scale Formation – Although the formation of lime and other mineral scale from water is generally considered a minor factor in cooling-system deposits, a brief discussion of the subject may be of value to vehicle operators located in hard-water areas. The total amount of dissolved solids in natural waters is not a reliable indication of the scale-forming ability of the water, although total hardness as to calcium carbonate may be used as an index of scale formation. Calcium and magnesium are the chief metal constituents in the hard-water scale. Excessively large amounts of calcium and magnesium carbonates and bicarbonates may lead to undesirable water-scale formation if large quantities of the hard water are constantly being added to the cooling system over a long period of time to replace leakage or overflow losses. Silica with large amounts of calcium or magnesium carbonate forms a particularly tenacious water scale. Rain water contains no scale-forming minerals.

With large additions of water and with high driving mileages, scale formation should be noticeable in water containing more than 500 parts per million of either calcium or magnesium or both. The average hardness of 12 surface-water supplies was found to be 103 parts per million. Hardness in water varies with rainfall and the variation is especially great in surface waters. For instance, samplings from the Mahoning River at Youngstown, Ohio, showed a 44% change in hardness during a 5-day period.

Water from some localities contains dissolved mineral salts that precipitate and form scale with evaporation of

the water; or scale may be formed by simply heating the water without boiling. Even in extremely hard water, however, the actual quantity of mineral salts that would produce scale is very small, especially as compared to the amount of iron rust normally formed. Probably the chief problem with water scale is the formation of localized lime deposits at hot spots near exhaust valve seats or between cylinders, where continuous boiling may be occurring.

F-2. Prevention of Water Scale – While several special commercial methods of softening cooling-system water have been reported in recent years, the practice has never gained more than limited use, according to available information. Lack of general interest in softening of radiator water may possibly be due to the absence of any real necessity for it except in certain local areas. Most water-softening methods would introduce chemicals into the cooling system. In one case sodium chloride is used to regenerate the softener. Such chemicals complicate the problem of rust inhibition and may cause foaming and overflow loss. The following preventive service methods are suggested to minimize water-scale formation:

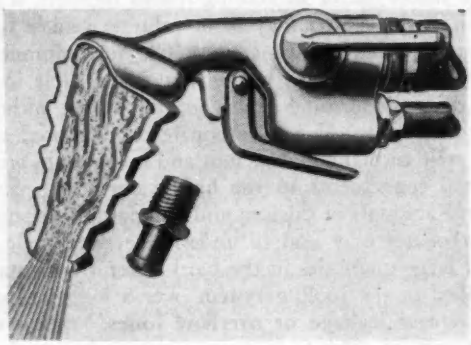
1. Avoid excessively hard water wherever possible. Use soft or rain water whenever conveniently available. Water softening equipment has been used in some localities.

2. Periodic preventive cleaning of cooling system to remove rust formations that would cause hot spots and local boiling.

3. Keep water additions down to an absolute minimum by eliminating overfilling and by a preventive maintenance program that will keep leakage and overflow losses down to a minimum.

4. Always use a corrosion inhibitor with water.

F-3. Preventive Cleaning of the Cooling System (Chemical) – Formerly, nearly all radiator cleaners were of the alkaline type, such as washing soda, or were organic solvents, such as kerosene. Although these materials cut grease and remove loose rust deposits, they are not entirely effective, since they have no solvent action on the rust itself and therefore do not remove hard scale in the radiator core or water jacket. A suitable cooling-system cleaner must be capable of removing adherent scale by dissolving action. Oxalic-acid and sodium-bisulfate types of cleaners have been found satisfactory in this respect and are specified by the U. S. Army. An acid cleaner should preferably be inhibited to reduce cooling-system corrosion to the minimum consistent with effective cleaning.



■ Fig. 28 – Cooling-system flushing gun and special nozzle for heater

F-4. Preventive Cleaning Procedure – 1. Completely drain the system, put in the recommended amount of acid cleaner and fill with fresh water. With the radiator covered, run the engine at least 30 min with the solution hot (at least 180 F, but below boiling). Stop engine and after a few minutes thoroughly drain the system. Because of the danger of overflow loss from foaming, do not drive the car with cleaning solution in the system.

2. Pour the recommended amount of neutralizer into the radiator, fill with water and run the engine until warmed up to driving temperature in order to circulate the neutralizer solution throughout the system and completely end all action of any undrained cleaner solution.

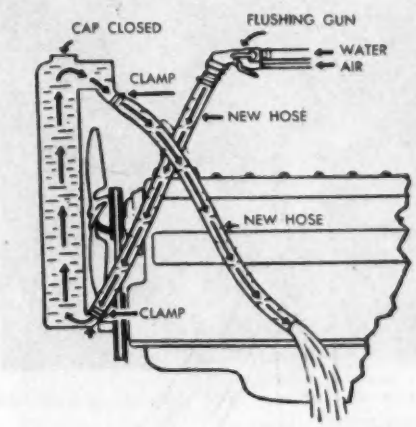
3. Flush the radiator and water jacket thoroughly with water to complete the cleaning operation before the car is driven. Do not leave the neutralizer in the system, since it is not a rust inhibitor.

4. After cleaning and flushing, check the thermostat; also clean out the overflow pipe and lubricate the water pump, if necessary, and blow insects and dirt from radiator air passages, grilles, and bug screen. In sealed cooling systems be sure that the valves in the radiator cap are free from sediment and properly seated.

F-5. Preventive Flushing Procedure – In the simplest method of flushing the cooling system, the drain cocks are opened, and with the engine running at lower speed, the radiator is kept filled by a stream of water from a hose inserted in the filler neck. The objection to this method is that cold water from the hose may close the thermostat and prevent thorough flushing of the water jacket.

Following the use of a cleaning solution, a more positive method for removing cleaner from the water jacket is to drain the solution completely, fill with water, run the engine long enough to open the thermostat for complete circulation through the system, then completely drain the water.

For the most complete removal of loose rust from radiator and water jacket, pressure flushing with an air-and-water gun is to be recommended, but this method requires opening the hose connections and removing the thermostat.

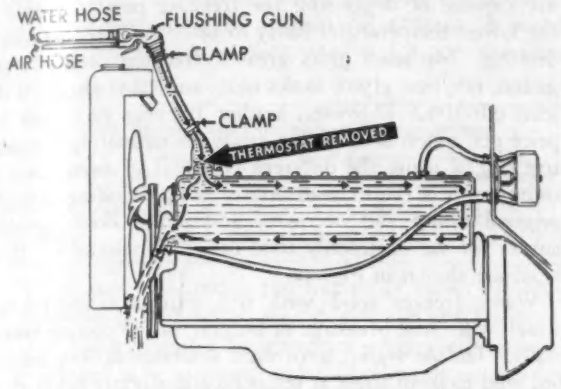


■ Fig. 29 – Pressure flushing of radiator

If there is a question about the effect of pressure flushing on the pump, follow factory instructions.

Periodic flushing with water may remove the loose rust, but is not effective for removal of hard, adherent rust scale. The use of an acid-type cleaner is first necessary to loosen or dissolve the scale.

F-6. Corrective Cleaning of the Cooling System (Chemical and Mechanical) – For cleaning clogged systems, follow the preventive cleaning procedure specified in section F-4, above, but increase the quantity of cleaning compound



■ Fig. 30 – Pressure flushing of engine block

in accordance with the manufacturer's directions and lengthen the engine running time as indicated by the condition of clogging. To avoid using excessive amounts of cleaner, time, and gasoline that might be required to dissolve all accumulations completely, pressure flushing is recommended and is sometimes necessary in the final flushing operation to remove any loosened but undissolved rust remaining in the radiator or water jacket.

F-7. Pressure Flushing Procedure – Facilities needed for pressure flushing are a special air-and-water flushing gun, designed for attachment to cooling-system hose connections, and compressed air and water supplies with hoses for attaching to the gun. The radiator and water jacket are first reverse flushed, that is, in the direction opposite to the normal flow of cooling liquid; then flushed in the normal direction of flow. (See Figs. 28 and 29.)

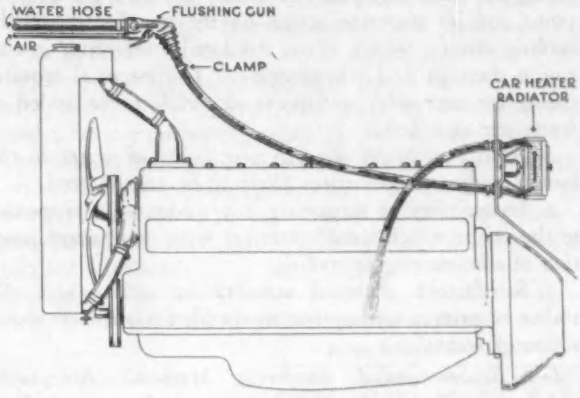
Flushing radiator – With the hoses disconnected, the radiator cap on tight, and the flushing gun clamped in the lower radiator hose, turn on the water and let it run until radiator is full, then apply air pressure gradually to avoid radiator damage. Shut off the air, fill the radiator with water, and again apply air pressure. Repeat the operation until flushing stream runs out clear. (See Fig. 29.)

Flushing water jacket – Remove the waterline thermostat, connect the flushing gun, and partly close the water pump opening to fill the engine with water before applying the air. Follow the procedure for flushing the radiator by alternately filling the water jacket with water and blowing it out with air (full pressure) until the flushing stream runs out clear. (See Fig. 30.)

Flushing hot-water heater – Disconnect the heater hoses and flush in the reverse and normal directions in the same manner in which the car radiator was flushed. Apply air pressure gradually to avoid damage. (See Fig. 31.)

F-8. Special Corrective Cleaning Methods – 1. For flushing out water jackets containing excessively heavy rust-sludge deposits, remove the core-hole plugs or cylinder-head studs, and pressure flush directly through the holes with a small flexible tube attached to the flushing gun nozzle.

2. In cases of very severe radiator clogging, the tubes may be so tightly plugged that the cleaning solution cannot reach all the clogging material. Such a condition usually requires the services of an experienced radiator repairman. One boil-out method used with good success for clogged



■ Fig. 31 – Pressure flushing of hot-water heater

radiators follows: (1) Remove radiator from the car; (2) close radiator inlet and outlet; (3) fill radiator with water; (4) add can of acid cleaner; (5) with the cap off and the radiator in an upright position over a gas flame keep the cleaner solution just at the boiling point until the rust is dissolved and loosened; then (6) neutralize the radiator; and (7) pressure flush.

3. If boil-out methods fail, the last resort is to remove the radiator tanks and mechanically clean the water tubes, by rodding.

4. Hydrochloric (muriatic) acid solutions are sometimes used for corrective cleaning badly scaled or rusted water jackets, particularly in rebuilt engines. One fleet operator reports completely dissembling the engine and closing all except top openings of the jacket. The acid is left in the block or head from 10 to 12 hr. Another operator, by means of special equipment, circulates heated acid through the water jackets with the engine assembled. Muriatic acid is used, both in standard strength and also diluted with water. Inhibited acid is reported to be highly desirable for reducing corrosive attack.

After draining the acid solution, neutralizing of the water jacket is necessary. Sodium carbonate in varying concentrations is reported to be used, followed by thorough flushing with water. Machined or polished surfaces must be carefully protected. In one case a heavy grease covering is employed for this purpose. Experience and care are highly important in the use of muriatic acid for water-jacket cleaning, both from personal hazard and equipment standpoints. The supplier's directions and precautions should be followed with care.

■ G. Properties of Antifreeze Materials

In the cooling systems of water-cooled automotive engines, the water functions as a heat transfer medium, carrying heat from the water jackets of the engine to the car radiator where the heat is dissipated to the surrounding air. Only about one-third of the energy in gasoline used to operate a motor vehicle is converted into power, the remaining two-thirds being converted into heat. In conventional design, about one-third of this heat is carried off

through the radiator, the remainder being dissipated through the exhaust and the outside surfaces of the engine.

Water is the natural selection for a cooling medium because of its relatively high heat transfer properties and availability. However, it has certain inherent disadvantages, the most important of which are its high freezing point and its corrosive action on the metal parts of the cooling system, which, if not inhibited, may result in corrosion damage and rust-clogging. The essential requirements for acceptable antifreeze materials to be added to water are as follows:

1. Ability to lower the freezing point of water to the lowest winter temperatures likely to be encountered.

2. Incapability of imparting any undesirable properties to the water which would interfere with its primary function of efficient engine cooling.

3. Satisfactory chemical stability in service and the ability to protect cooling-system metals from the corrosive action of water.

G-1. Recommended Antifreeze Materials – Acceptable and commonly used antifreeze materials are ethylene glycol, ethanol (denatured ethyl alcohol), methanol (synthetic methyl alcohol), and isopropyl alcohol. Standard antifreeze products using any one of these materials also contain chemical ingredients known as inhibitors to increase their chemical stability and to prevent corrosion. All these antifreeze materials are organic and nonelectrolytic.

G-2. Nonrecommended Antifreeze Materials – Oils, sugars, and inorganic salt solutions are unsatisfactory for one reason or another. The hazards of using inorganic salts, such as calcium chloride, and petroleum oil distillates, such as kerosene, have received wide publicity recently from authoritative Government agencies and automotive experts, and simple methods of testing to determine such unsuitable or deleterious compounds have been widely published.

The principal objections to inorganic salt antifreeze materials are electrical conductivity and corrosive effects. Leakage of salt antifreeze solutions onto the ignition system parts will cause serious shorting of electrical circuits. To date, no chemical treatment is known which will inhibit salt antifreezes against corrosion in the cooling system, even though they may produce satisfactory corrosion results in laboratory tests. Another objection reported on salt antifreeze is the possibility of crystal formation in the radiator which would restrict circulation.

Kerosene and similar oils are low freezing liquids, but cannot be used to depress the freezing point of water because they do not mix with water.

Because of their low heat transfer properties, oils are not suitable as coolants in engines designed for water cooling and under heavy load or at high speed serious engine damage from overheating can result from their use. Since oil vapors are inflammable, a very real fire hazard is presented when boiling and overflow of the oil occurs with overheating of the engine. Mineral oils have a solvent action on rubber and their use in the cooling system will result in rapid deterioration of rubber hose connections and rubber seals in water pumps.

Sugar solutions (including honey and molasses) may become excessively viscous at low temperatures and cause inadequate circulation and overheating in the cooling system. Charring of sugars will seriously interfere with heat transfer from the engine and charred deposits in the water jacket will present a most difficult cleaning problem.

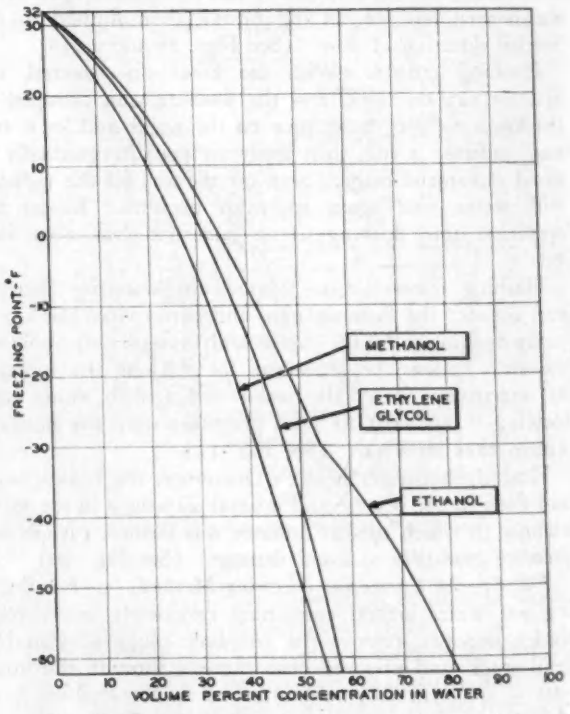
■ Organic Antifreeze Solutions

The discussion which follows on the physical and chemical characteristics of antifreeze solutions is confined to ethylene glycol, methanol, and ethyl alcohol.

G-3. Freezing Protection – All three recommended types are capable of depressing the freezing point of water to the lowest temperatures likely to be encountered in vehicle driving. Methanol gives greatest freezing protection per gallon, ethylene glycol ranks next, and ethyl alcohol is the least effective. However, neither freezing protection nor price per gallon is a reliable guide for estimating comparative cost of using the different types. The correct basis of comparison is the over-all winter cost, including both the original filling and necessary additions. Freezing point curves for the commonly used concentrations of the three types are shown in Fig. 32.

Water freezes solid with 9% expansion in volume, which will cause breakage or bulging of the cooling-system walls. Unlike water, antifreeze solutions do not solidify but tend to form slush at temperatures slightly below their freezing points. Laboratory tests in thin-walled glass tubes have shown that as little as 10% antifreeze in water will prevent breakage damage from freezing at temperatures as low as —40 F. To explore the behavior of antifreeze solutions in the cooling system at temperatures below their initial freezing point, cold-room tests were made in which several popular vehicle models were chilled to low temperatures, following which the engines were started up and operated. Typical results from these tests are shown in Table 1, indicating the range of minimum safe temperatures to which solutions having zero degrees' freezing point may be subjected without overheating or other difficulties developing from slush ice restriction in the radiator when the engine is operated immediately after chilling.

Since the minimum safe exposure temperature below



■ Fig. 32 – Freezing points of common antifreeze solutions

the freezing point varies with antifreeze materials and solution concentrations, as well as with the design of the cooling system, the only safe recommendation for installing antifreeze protection is on the basis of the initial freezing point of solution. The published freezing protection tables furnished with standard antifreeze products should be followed in determining the amount of antifreeze necessary in any given size of cooling system for the protection desired.

Table 1 – Minimum Safe Temperatures of Antifreeze Solutions

Antifreeze	Freezing Point, F	Minimum Temperature, F
Methanol	0	−2.5 to −5.5
Ethanol	0	−5.5 to −8.0
Ethylene glycol	0	−8.0 to −11.5

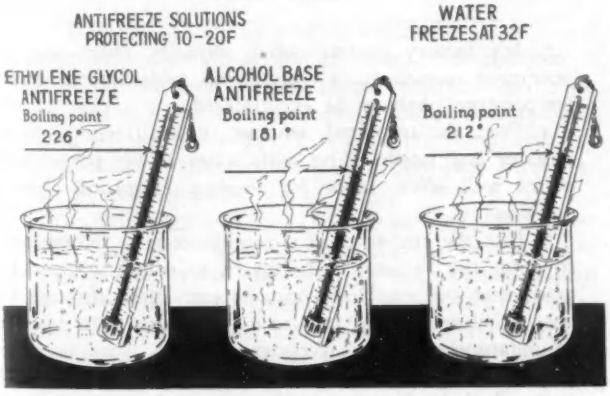
When using antifreeze, the hazard of under-protection is overheating and heat-cracking, not freeze-cracking.

G-4. Boiling-Point Characteristics – Automotive engines are designed to be operated without boiling of water within the recommended limits of speed and load. It is obvious that if cooling-liquid temperatures rise above the boiling point of the liquid, the natural result will be overflow losses and overheating from liquid shortage in the system. As a rough indication of cooling-liquid temperatures in ordinary driving, attention is called to the range of rated thermostat valve opening temperatures for 35 vehicle models of 1940 and 1941 make, shown in Table 2.

Table 2 – Operating Temperatures of Factory-Installed Thermostats in 1940 and 1941 Cars

Number of Makes and Models	Opening Temperatures, F
1	Below 145
6	145–150
14	150–155
14	155–160

It should be pointed out that these opening temperatures represent only minimum theoretical solution temperatures, since the rated wide-open thermostat temperatures in those models vary from 170 to 185 F, and, therefore, the actual liquid temperatures in normal cooling-system operation will lie between the opening and wide-open temperatures. To the temperatures indicated above, upwards of 20 deg must be added for the normal temperature rise in the cooling liquid immediately after stopping the vehicle. If boiling and its attendant troubles are to be avoided, the maximum solution temperature reached after stopping the vehicle or engine must be below the boiling point of the solution.



■ Fig. 33 – Sea-level atmospheric boiling points of water and of antifreezes giving protection down to −20 F

As a guide for selecting the type of antifreeze best adapted to maximum cooling-liquid operating temperatures, in any particular vehicle or fleet, the figures in Table 3, giving the boiling points at sea level of the three different types, for freezing protections from +10 to −20 F, should be of value to the vehicle operator. It will be noted that the solution boiling points of methanol and ethanol types are lowered with increase of concentration and freezing protection, while in the ethylene-glycol type the solution boiling point raises with higher concentration and increased freezing protection. In the freezing protection range of +10 to −20 F, the boiling points of ethylene-glycol solutions are 28 to 43 deg higher than the alcohol solutions.

Table 3 – Boiling Points of Commercial Antifreeze Solutions

	Boiling Points of Solutions, F			
	Freezing at +10 F	Freezing at 0 F	Freezing at −10 F	Freezing at −20 F
Methanol type	190	185	182	197
Ethanol type	187	184	182	180
Ethylene-glycol type	218	220	221	223

The boiling point of water is lowered by additions of ethanol and methanol and raised by additions of ethylene-glycol in proportion to the amounts added. Graphically illustrated in Fig. 33 are the sea-level atmospheric boiling points of water and of ethylene-glycol and alcohol solutions giving protection to −20 F. Methanol, ethanol, and ethylene-glycol antifreeze products are commonly distributed in concentrations of approximately 94 to 99½%. The boiling points of concentrated products should not be confused with the boiling points of commonly used solutions which rarely exceed 50% concentration even in the coldest areas of the country. Alcohol solutions cannot usually be used with thermostats opening at 160 F, or higher, unless the cooling system is equipped with a pressure valve or surge tank (radiator overflow tank).

G-5. Effect of Altitude and Pressure on Boiling Point – The boiling point of water and antifreeze solutions drops about 2 F for each 1000-ft rise in elevation, which of course increases the possibilities of boiling and overflow loss with high-altitude driving. On the other hand, radiator-cap pressure valves in sealed cooling systems raise the boiling point of water and antifreeze solutions. For example, in an airtight system with a pressure valve which opens at 5 psi pressure, the boiling point of the cooling liquid may be raised 13 to 15 F.

G-6. Foaming Tendencies of Cooling Liquids – Air entrainment in the cooling liquid is a condition which may occur during operation at higher speeds and, if excessive, may cause overflow loss of water or of any antifreeze solution. Some natural and contaminated waters have a greater tendency to foam than others. This does not refer to the head of foam on the surface of the liquid, but to the small air bubbles which are caught and held in the body of the liquid, increasing its volume. Overflow losses increase with the tendency of a liquid to retain finely divided air bubbles. The addition of antifreeze materials to water should not cause any appreciable increase in foaming and low foaming tendencies are, therefore, desirable in antifreeze products.

The need for keeping the foaming tendency of antifreeze solutions down to a minimum is indicated in Table

4, showing the comparative overflow losses in inhibited and uninhibited ethylene glycol on a dynamometer test of one high production engine. Although high road speeds are banned for the duration of the war, the prevalence of high engine speeds in the lower gears is still a factor affecting air entrainment and possible foaming and overflow in heavily loaded commercial vehicles.

Table 4 – Comparative Foaming Data in 1939 Cooling System [1]

Antifreeze Type	Solution Temperature, F	Solution Loss After 1000 Miles, cc
Untreated ethylene glycol	180	1000
Improperly treated ethylene glycol	180	4000
Properly treated ethylene glycol	180	75

[1] Dynamometer test: 60 mph, solutions of freezing point 0 F.

G-7. Creepage of Antifreeze Solutions – Uninhibited antifreeze materials have some tendency to loosen rust and creep through rust-filled crevices in the cooling system which previously have been plugged leaktight when using only water. Leakage-rate tests in laboratory apparatus and in vehicles have shown that this is particularly true of untreated ethylene-glycol solutions. However, in standard ethylene-glycol products containing inhibitors, the leakage rates of solutions have been found to be substantially lower than that of water.

G-8. Thermal Expansion of Antifreeze Solutions – Both water and antifreeze solutions expand when heated up, making it necessary to leave an adequate air space in the radiator when the liquid is cold in order to avoid overflow losses from thermal expansion at driving temperatures. Ethanol, methanol, and ethylene-glycol antifreeze solutions all expand somewhat more than water when heated, but not nearly to the extent popularly believed. To give an idea of the relative thermal expansion rates of various antifreeze solutions as compared to water, the approximate amounts in pints expansion per gallon of liquid are shown for the temperature range of 40 to 180 F, in Table 5. The cost of antifreeze, and its scarcity during the present emergency, make it imperative that expansion losses from overfilling of the radiator be avoided.

Table 5 – Thermal Expansion of Water and Antifreeze Solutions [1]

Type of Antifreeze	Solutions Protecting to— 20 F	0 F	−20 F
Ethylene glycol	0.29	0.34	0.37
Methanol	0.26	0.37	0.44
Ethanol	0.31	0.47	0.54

[1] Pints expansion per gal of liquid between 40 and 180 F. Water, 0.24 pt per gal.

G-9. Chemical Characteristics of Organic Antifreeze Solutions – While water itself is chemically very stable, it attacks certain cooling-system metals quite vigorously under the influence of conditions of heat and aeration constantly present during cooling-system operation. Therefore, the cooling liquid, whether water or water solutions of antifreeze materials, must always contain a corrosion preventive if metal attack and rust formation are to be avoided. Inhibitors contained in standard organic antifreeze products greatly reduce the attack of water on metals and also stabilize the antifreeze materials chemically so that effective corrosion prevention can be maintained in a normal cooling system for at least one antifreeze season.

The necessity for using corrosion inhibitors in the organic antifreeze materials is shown in Table 6, showing the comparative corrosion weight losses of various cooling-system metals in inhibited and uninhibited organic antifreeze solutions and in water, as determined by a laboratory corrosion test. With inhibited liquids, the reduction in the corrosion of iron is particularly outstanding and the indicated protection to aluminum, copper, brass, and solder strongly recommends the use of summer rust preventives with water as well as the use of suitably inhibited antifreeze. However, laboratory corrosion tests cannot be depended on to predict the corrosion effects in the cooling system of inorganic salt antifreezes such as calcium chloride.

Table 6 – Corrosion Tests on Treated and Untreated Antifreeze Solutions [1]

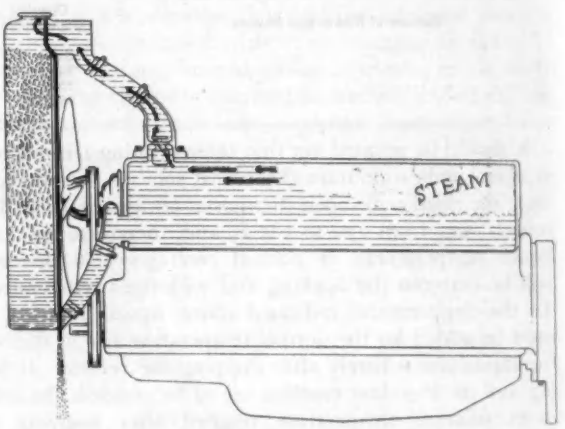
Test No.	Weight Losses, mg per 12 sq in. per 200 hr at 170 F: Iron	Aluminum	Copper	Brass	Solder
1. Untreated methanol	1995	49	29	43	34
2. Commercial methanol inhibited	1	1	10	2	10
3. Untreated ethanol	1390	21	42	4	18
4. Commercial ethanol, inhibited	0	3	23	8	23
5. Untreated ethylene glycol	793	45	101	101	267
6. Inhibited ethylene glycol	0	0	1	1	40
7. Distilled water	1524	5	93	93	234
8. Inhibited water	0	4	32	20	32

[1] All solutions except No. 7 and 8 of freezing point 0 F.

G-10. Suggestions for Installation, Testing, and Servicing of Antifreeze – 1. Inspect the cooling system and perform any necessary services to ensure that it is clean, leaktight, and in proper working order.

2. Completely drain the system by opening all drain cocks or plugs on both engine and radiator. Use a cleaning solution, if necessary, or at least flush thoroughly with water.

3. Determine the quantity of antifreeze to use from the vehicle's factory cooling-system capacity chart and the antifreeze manufacturer's protection table for the lowest temperature likely to be encountered.



■ Fig. 34 – Slush freeze-up in radiator and overheating from unmixed solution

4. Pour the required amount of antifreeze into the radiator and finish filling with water *to the proper level which will allow room for thermal expansion without overflow.*

5. Run the engine until it reaches driving temperature, covering the radiator if necessary in order to open the thermostat and establish complete circulation through the system before driving the car or exposing it to freezing temperatures. This is necessary:

a. To completely mix the water and antifreeze and prevent a slush ice freeze-up. (See Fig. 34.)

b. To remove any trapped air in the engine, after which it may be necessary to add more water. (See Fig. 35.)

6. Inspect the solution and test for freezing protection at least once a week. Always make the test before adding antifreeze or water and with the solution warm. Carefully follow the instructions furnished with the tester.

7. Replace leakage and overflow losses of solution with a mixture of water and antifreeze to give the same strength as the original filling.

8. In case of insufficient protection or diluted solution, use the table or chart supplied by the antifreeze manufacturer to calculate the amount of additional antifreeze needed.

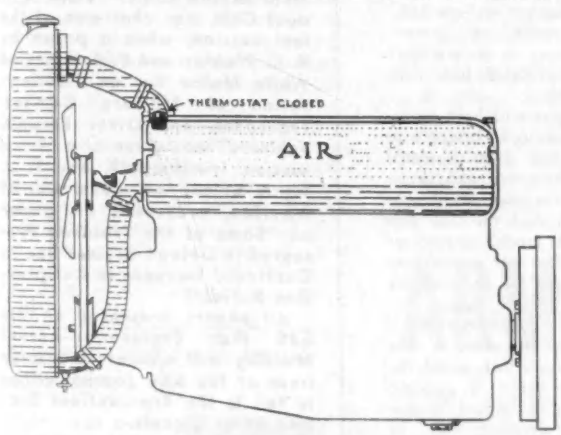
9. Antifreeze testers:

a. Simple hydrometers without a thermometer or temperature correction chart can only be accurate for one solution temperature, usually 60 F.

b. Commercial testers which will accurately read freezing protection at any solution temperature within the thermometer scale (usually 60 to 160 F) are recommended.

c. Testers designed for any one type of antifreeze (ethanol, methanol, or ethylene glycol) cannot be used for the other types.

d. Recommended tester requirements for minimum testing accuracy are: (1) all-glass float with scale at least 2 in. long and not less than 13 divisions covering the range of commonly used concentrations; (2) range of thermometer scale 60 to 160 F, with not greater than 10 deg temperature divisions; (3) correction chart with same number of divisions as float and thermometer scales.



■ Fig. 35 – Showing how air is trapped in engine by closed thermostat

e. To check the accuracy of an antifreeze tester, use a solution of known freezing protection. For instance, a solution of one-third ethylene-glycol antifreeze and two-thirds water gives zero protection, and a half-and-half solution protects to −34 F. Check the tester accuracy with solution at different temperatures within the range of the thermometer scale.

G-11. Conservation of Used Antifreeze Solutions – Summer of 1943 and Winter of 1943-1944 – To be assured of an adequate supply of antifreeze for next winter, civilian motorists should conserve the past season's antifreeze solution. This is advisable because increased war demands for antifreeze chemicals make uncertain an adequate supply for future civilian use.

In normal times the ideal procedure is to install a fresh filling of inhibited antifreeze, but for the duration of the war it is essential to save such critical materials wherever possible. On the other hand, it is just as important to prolong the life of cooling-system parts also containing critical materials and for this reason the continued use of antifreeze solution that may be corrosive should be avoided.

Corrosion inhibitors in antifreeze may be weakened and exhausted by extended or hard use. Such variables as driving mileage and speed and the condition of the engine and cooling system are important factors in the noncorrosive service life of solutions. Contaminated antifreeze solutions with exhausted inhibitors may cause more corrosion and rust formation than untreated water if their use is continued indefinitely.

The following procedure is suggested to reduce the hazards of corrosion, rust-clogging, overheating, and freeze-up to a minimum, in the absence of any special recommendations from the antifreeze or vehicle manufacturer.

1. Determine if the antifreeze solution is one of the recommended types, alcohol or ethylene-glycol. If the antifreeze is found to be a deleterious salt or oil type, it should be drained and discarded immediately and the cooling system should be thoroughly cleaned and flushed.

2. Check the solution with a suitable antifreeze tester and record the temperature to which it is protected. Very weak solutions may not be worth saving.

3. Preserve the antifreeze solution in a satisfactory manner. This may be done by draining the solution and storing it in clean, labeled, and sealed containers, preferably glass or earthenware. If the solution is the ethylene-glycol type it may be necessary to leave it in the cooling system to avoid the possibility of drainage losses. At the present time, this practice is made possible by low car mileage as controlled by gasoline rationing and by limited driving speeds. Either of the following tests may be used to determine if solutions are suitable for further use:

a. Dip blue litmus paper in the antifreeze solution. If it does not turn a distinct pink or red, it is suitable for further use.

b. Allow a sample of the solution to stand overnight in a clear glass container. If the solution is suitable for further use, it will clear up practically water-white or with at least a trace of the color of the original solution.

If the blue litmus paper turns a distinct pink or red when dipped in antifreeze solution or if the solution upon standing does not clear up, it should be discarded.

4. Before stored solution is returned to the cooling system in the fall, it should be tested again for antifreeze strength. If necessary to increase freezing protection, fresh material, preferably of same brand, should be added.

5. When antifreeze of the ethylene-glycol type is used for more than one winter, it should receive more than normal inspection and test. A special reinhibitor made and recommended by the manufacturer of the antifreeze in use in the car should be used. Other inhibitors, regardless of their suitability or lack of suitability for other purposes, must not be used for this purpose.

6. The mixing of different brands of antifreeze in the cooling system should be limited to those having the same basic materials, such as ethylene-glycol or alcohol. Mixtures of ethylene-glycol and alcohol cannot be correctly tested with a commercial antifreeze tester.

Attention should be called to the further necessity of following the car manufacturer's normal recommendation for the cleaning, preservation, and proper care of the cooling system.

Design Patterns Jell on Future Cars, Trucks

DESIGNERS of tomorrow's automobiles and trucks left the 1944 SAE War Engineering-Annual Meeting with cogent new ideas about improved components, a mass of the latest available information on prospective new materials—and a New Year's present from the Army in the form of test data worth many thousands of dollars. Tires, tracks, winterization practices, fuels, and a variety of vehicle components stand to benefit. . . . Again and again, the paradox of war showed in bold relief, as engineering impossibles achieved to save the blood of fighting Americans were offered as a heritage to them when they, who do, return.

Not in the broad strokes of an impressionist artist, but rather in the fine lines of steel-point etching was the outline of post-war vehicles sketched by many speakers.

Plastics were demonstrated to be successful in structural-part applications hardly dreamed of in pre-war technical thinking; they were argued as having strictly limited applications for such parts in immediately post-war cars and trucks. Clear plastics, for example, were discouraged for vehicle windows as compared to glass. They were said to have a lower factor of surface hardness, to be inferior in optical qualities, and still to be subject to scratches too deep for satisfactory removal by buffing.

On the other hand, one session was electrified by dramatic presentation of some phenolics, vynyls, and their products developed to confound the Axis. . . . Savings in weight over previously used light materials, reductions in cost despite higher cost per pound of material (through reduced fabricating costs) were demonstrated to emphasize again to automotive designers the continuing challenge of the newer plastics.

Light metals in general and aluminum in particular came in for similar pro-and-con discussion. The price-quantity available-engineering ability relationships in the aluminum situation were rehearsed by several speakers, the result being more or less a draw as on several previous occasions. Proponents of widespread aluminum use in motor vehicles are optimistic about prices for some grades getting down near cast-iron.

Chances for aircooled engines in passenger cars, it was brought out, probably will depend heavily on which side of this argument turns out to be correct. A satisfactory aircooled car engine, the reasoning goes, cannot be developed without extensive use of aluminum's heat-dissipating properties—and possibility of extensive use depends on quantities available at cast iron prices.

More precise engineering knowledge of steels, it seems generally agreed, will be an important byproduct of the present war emergency. Speakers said we may expect to hear less and less of chemical properties in specifying steels and more and more about physical characteristics as an important heritage from current work being done jointly by the SAE, other engineering societies, and the Government. Hardenability seems destined to be a most useful tool for future designers.

Carbon steels carrying a minute mixture of boron salts—variously known as "needled," "S.A.," "additive," "treated," or "intensified"—were stressed, too, as a war-born metallurgical miracle performed jointly by steel mills and fabricators.

Car and truck engineers will have to design engines with an eye to fuel supply as well as fuel type, factual data presented would imply. Both automotive and petroleum technologists, it was said, are beginning to see the future through the clear lens of miles per barrel of crude, instead of through the distorted miles per gallon eyepiece—"100 octane oracles" to the contrary notwithstanding.

Gasoline octane numbers won't crawl much above 90 (ASTM) even by 1960, it was predicted in one discussion which stated the economics of refining a barrel of gasoline simply. Forced output of higher octane fuels, necessary during desperate days of total war, it was posited, would be willful waste of some 9,000,000 bbl of crude per year if continued when unnecessary in peacetime . . . all of which corroborated as well as amplified the views of Brown, Colwell, James, Roensch and other recent SAE commentators on the same subject.

From extensive, recent Army tests came tire data of vast significance to post-war car and truck designers. Military engineers brought synthetic tire tests results which confirmed dramatically the estimates of these tires' current abilities sketched at previous SAE meetings by Drew, Torrance and others.

Essence of that estimate: Synthetic tires are not yet as good as those made by natural rubber. The gap between the two is steadily being narrowed, however. . . . Currently the performance of synthetic tires on both civilian and military vehicles is quite satisfactory, provided the tires are not overloaded and high temperatures are not generated.

Recently completed Army Desert Command tests on flotation of tires and tracks in sand and mud brought one contrary-to-common-belief conclusion about the relative desirability of single and dual wheels under such conditions. In tough going of that kind, a large single tire performs better than duals.

Other conclusions from this particular set of tests included:

1. Successful operation in sand, mud and snow demand all-wheel drive;

2. Only soft large tires provide sufficient flotation to stay near the surface and enough traction to enable the vehicle to move forward;

3. Power greater than that transmitted effectively by the tires is wasted unless it can be distributed to more driving axles.

The most comprehensive picture of prospective post-war passenger cars at this meeting was devoted to proving that "air-brush

TRUCK & BUS SESSIONS

E. W. ALLEN

Truck designers got concrete ideas about what fleet men want in post-war trucks at one technical session held under the auspices of *Vice-President E. W. Allen's* Truck & Bus Activity Committee. *Major-Gen. G. M. Barnes*, principal dinner speaker, was the second speaker brought to this War Engineering-Annual Meeting by the T & B group. *E. M. Schultheis* presided at the post-war truck session, while *L. R. Buckendale* was responsible for arranging for Gen. Barnes' address.

All papers presented at this SAE War Engineering-Annual Meeting will appear in a later issue of the SAE Journal either in full in the Transactions Section or as digests.

PASSENGER CAR SESSIONS

R. E. COLE

Aircooled engines, gasoline, tires, and bolts were among the varied topics holding the attention of the audience at the three sessions developed by *Vice-President R. E. Cole* and his Passenger Car Activity Committee.

Papers on "Aircooled Engines in Automotive Vehicles," by *Chester S. Ricker*, Detroit Editor of *Wings*, and "An Informal Long-Range Forecast of Motor Gasoline Developments," by *D. P. Barnard* and *R. F. Marschner*, Standard Oil Co. of Indiana, were given at the session presided over by *J. G. Wood*. "Tire and Track Flotation of Military Vehicles," by *Lt.-Col. J. E. Engler* from Camp Seeley, and a paper entitled "On the Strength of Highly Stressed, Dynamically Loaded Bolts and Studs," by *J. O. Almen* of GM Research, were presented at the second session, with *J. E. Hale* in the chair. *Vice-President Cole* was chairman of the last session, when a paper by *R. L. Weider* and *B. F. Jones* of White Motor Co. on "Winterization of Military Combat, Transport, and Other Purpose Vehicles" was given at a closed session (restricted), and *E. J. Willis* of the Aluminum Co. of America, presented his paper on "Some of the Problems Presented in L-Head Engines Due to Continued Increase in Compression Ratios."

All papers presented at this SAE War Engineering-Annual Meeting will appear in a later issue of the SAE Journal either in full in the Transactions Section or as digests.

1944 SAE War Engineering-Annual Meeting

designers have misled the American public about what to expect and to demonstrating why progress to structures totally different from pre-war types will be gradual.

Examination of possibilities of air-cooled engines for passenger cars by another speaker indicated that, engineering-wise, the possibilities are good. Engine cylinder temperatures need not be any higher than those of water-cooled engines, it was contended, and aviation engine aircooling has advanced far beyond the needs of automobile installations so that it is only a case of building engines to meet those needs. The aircooled engine, moreover, was said to be especially well adapted to rear-engine installations – which continue to figure prominently whenever the car of the future is discussed. The road load characteristic of car engines are such, it was said, that it might be possible to cool them by exhaust-created suction instead of a fan.

Tied closely with future fuel-engine relationships, of course, is the trend toward ever increasing compression ratios – and the eventual effect of this trend on L-head engine design possibilities was another post-war car idea explored at this meeting. Essence of conclusions reached were: (1) That 8½ to 1 compression ratio is about as high as will be desirable; after that advantages are outweighed by disadvantages; (2) the overhead valve engine has nothing to gain over the L-head engine at that point. . . . "The number of difficulties in operation for the average driver precludes the use of ratios over 8.5 to 1 in either type" (E. J. Willis, Aluminum Co. of America).

Most striking contribution to thinking about post-war truck design – aside from Army data about tires – came from a survey covering ideas of some 300 truck fleet operators about what they want in their post-war commercial vehicles.

Surprise result: These experienced users apparently think there isn't much wrong with engines, transmissions, frames, axles and other major units as they now exist. These items, which the average designer considers the essential units, caused little adverse comment. But cooling systems, electrical systems, cab design for driver efficiency – and all-over accessibility came in for plenty of criticism and suggestions-for-improvement. Some commentators about the meeting felt that these latter elements were found wanting because the average design engineer has not considered them of major importance. . . . In any case, valuable and effective exchanges of views took place.

The composite views of these operators may give an idea of some design changes which might take place.

The fleet men were hot about cooling systems and cool about crankcase heaters. With maintenance of proper coolant level a basic instruction in equipment operation, it was pointed out as an example, some trucks have the radiator fill and subsequent top hose so arranged that the filler level can't be seen until the top tank is filled completely. (And operation at such high level means coolant loss both by expansion and surge – a defect of vast importance with antifreeze in winter.) Assuming no immediate revolutions in cooling system design to be brewing, the fleet operators want existing conventional systems to be more easily accessible for checking, tightening and replacing connections and parts.

Electrical circuits and wiring – as they appear on the average truck – were almost universally condemned as inferior in quality and lacking in accessibility. Characterized as "a modern mystery," in fact, was "the poor quality of wires, switches and connectors, fuse blocks or lack of adequate fuses, such as we find, when we consider the slight extra cost for the best."

Practically all fleet operators and all heavy and medium-duty truck users seem to want unit engine replacement made easy, even at the sacrifice of some other quality – but light truck users aren't interested unless no sacrifice is involved.

Everybody thinks truck cabs can be improved – and would like passenger-car standards when it comes to comfort, sealing around doors, pedals, and so forth . . . but much better than passenger-car standards on hardware and vision.

MATERIALS SESSIONS

R. H. McCARROLL

Although new in SAE organization, the Materials Meetings Committee rang the bell with resounding resonance with two sessions. *Chairman R. H. McCarroll* and his committee offered two sessions with five stimulating and informative papers. Under the chairmanship of *W. J. McCortney*, the first session presented *L. W. Kempf*, Alcoa, on "Considerations Regarding Post-War Utilization of Aluminum and Magnesium"; a paper by *Dr. A. A. Somerville*, R. T. Vanderbilt Co., on "The General Purpose Synthetic Rubbers in the Automotive Industry," and *Gordon Brown*, Bakelite Corp., on "Wartime Plastics Applications and Their Peacetime Implications." *W. H. Graves* led the other session when a paper by Mr. McCarroll and *J. L. McCloud*, Ford Motor Co., on "Quality Control of Engineering Materials" was presented by the latter, and a paper on "Effects of Wartime Developments on Future Steels" was given by *W. P. Eddy, Jr.*, prepared while he was with GMC Coach & Truck prior to joining Pratt & Whitney Aircraft.

PASSENGER-CAR BODY SESSION

G. J. MONFORT

Post-war cars and the Army "Duck" were discussed at the single session produced by Vice-President *G. J. Monfort's* Passenger-Car Body Activity Committee.

***I. L. Carron* was chairman of this session. Papers presented were: "The Practical Post-War Car," by *E. C. De Smet* of Willys-Overland, and "Amphibian Truck Developments," by *Col. E. S. Van Deusen* of Ordnance.**

All papers presented at this SAE War Engineering-Annual Meeting will appear in a later issue of the SAE Journal either in full in the Transactions Section or as digests.

ARMY Vehicles *Hold Stage*

ARMY vehicles of both Axis and Allied nations were described and analyzed for the benefit of the automotive industry engineers who are co-designing and building America's war equipment. Tests of Army vehicles by officers of the Desert Training Command and the Office of the Chief of Ordnance, Detroit, brought data vital to improvement of military trucks and truck operation. Data derived from these tests are equally applicable to civilian truck operation in most instances, especially in off-the-highway use.

Some of the conclusions reached by Major-Gen. G. M. Barnes in his description of captured enemy equipment have been recorded in previous paragraphs. His entire paper will be published in the March issue of the *SAE Journal*.

Amphibian truck developments topped the material about American military vehicles developed at the meeting. It was shown that the amount of water that can be taken aboard by the amazingly seaworthy 2½-ton amphibious truck known as the "duck" is surprisingly large, due to the special attention given in design to the power bilge pump equipment. The project of developing the "duck," it was revealed, was initiated very shortly after the release of orders for quantity production of the amphibian "jeep" in April, 1942. In view of the experience gained and success attained in the ¼-ton field, the same agencies, i.e. the National Defense Research Committee, with Sparkman & Stephens, Inc., carried out the supervision of the detailed work at Yellow Truck & Coach. Messrs. C. O. Ball, 1942 SAE Vice-President Everett Allen, W. F. Klein, and E. H. Todd, and their assistants, were given special mention by Col. E. S. Van Deusen as "spark plugs who were directly responsible in the factory for production and successful demonstration at sea of a pilot model in six weeks' time."

Besides slides showing hull and power-train installations, films were shown of tests and the sea-going vehicles actually working with the troops in the South Pacific, with American battleships out near the horizon and American scouting planes overhead.

1944 SAE War Engineering-Annual Meeting

Aeronautics *Papers Open Broad Vistas*

AVIATION'S automotive engineers argued and studied various important aircraft engine and structural problems, and did some peering into the industry's post-war future, with healthy differences of opinion, at the SAE War Engineering-Annual Meeting.

Post-War Planes Argued

Most significant from a post-war standpoint were studies of the new possibilities for mass marketing of private airplanes, the various engineering and production problems to be overcome, and a proposal for return to lighter-than-aircraft for more economical long-range air cargo transport. Significant too was the SAE Council's decision at its Jan. 14th meeting to organize an Air Transport Engineering Activity to supplement activities serving manufacturers of aircraft, engines, parts and accessories and to study aircraft operators' problems.

Technical discussions on the aircraft engine ranged from an appraisal of synthetic rubber uses on engine, to a study of civil aircraft engine failures during the last two and one-half years, and also gave advocates of the aircooled and liquid-cooled engines a chance to air out their old argument again.

Aircraft structural engineers had their innings with discussions ranging from the British DeHavilland Mosquito fighter-bomber, which almost got called the fastest plane in the world, to the transformation which was worked on the Douglas DC-3 to make the C-47 military transport.

Vapor lock, that high altitude bugaboo which stops aircraft fuel systems and makes engineers grow gray, came in for a three-way thumping in a symposium, while other fuel and materials problems also got a going-over. And for topping, the last thing on the program was a movie showing how to make landings cross-wind, which set the debaters to arguing all over again.

The post-war personal plane market is going to mean a lot of extra work for the engineers, designing more safety and utility into planes and designing cheaper engines, if a mass market is ever to be expected in that field. The "philosophy-of-scarcity" advocates, who would destroy surplus war aviation equipment or hold it until it has lost its value, took a verbal walloping with a warning that if the aviation industry tries to limit production or make useless goods already in existence, such action will be followed by other groups with resultant increases in costs of all commodities, and fewer customers to buy private planes.

Actual price quotations on light planes of the future, at the meeting ranged from a $1000 plane, the cheapest that will fly satisfactorily, in one engineer's opinion, to a $3000 four-or-five place plane, with a sleek little low-winged monoplane with retractable wheels for $2000 and a super-safe $1500 plane, both two-seaters.

Agreement was general that the much-publicized helicopters are still far from ready for the average man to fly, and that the immediate development in personal planes would be in fixed wing aircraft, with a possibility of roadable airplanes pushing their versatile noses into the picture. Despite engineering compromises required in such a design, it was estimated that the all-weather usefulness of the air-and-surface vehicle – which is designed to land and fold or check its wings when the ceiling closes in to continue its journey on the highways – might give it a year-round utility and average speed greater than the conventional light plane. Other engineers, however, argued that the roadable plane was neither a good airplane nor a good automobile.

Importance of building safety and utility into planes was thumped home repeatedly. Public popularity of the helicopter, it was pointed out, is indication that the public wants utility rather than speed. CAA surveys, seeking opinions of flying students, plane owners and ex-plane owners, were quoted as putting utility and safety considerably above speed in their requirements.

Spin-proof characteristics, mechanical coordination of rudders and ailerons, automatically operating slots, flaps and spoilers, and tricycle gears, will be much-desired attributes of the post-war plane, while pusher planes may eventually prove the solution to a need for improved visibility. Twin-engine safety, controllable, or at least two-position propellers, and the possible use of gasoline turbines for powerplants for light planes, were other suggestions. A suggested design for a four-place future plane shown during the meeting had twin tail booms like a P-38, with twin gasoline turbines as powerplants. Lower-cost floats for light-plane use, made from plastics, may be available after the war, it was indicated. Designing of light planes in component parts so that a repair man can substitute a good wing, aileron or tail group for a damaged one, restoring the plane to service while the damaged part is repaired – as service stations handle motorists' tires or batteries today – was suggested as a future service development.

Without adequate landing and service facilities, close to the nation's cities and smaller towns, the private plane will lack the utility necessary to become a mass production possibility, the personal plane planners agreed. Appeal was made to design planes capable of better cross-wind landings, in order to make possible the use of one-direction landing strips on a large scale throughout the country. The tricycle landing gear is only a partial step in this direction, it was asserted. With planes with good cross-wind characteristics construction of elevated one-direction runways in the heart of a city would be no more impractical than elevation of railroad tracks. Yet another suggestion was to build a number of such one-direction runways, over a general area, running in various directions, so that the flyer might pick his landing strip according to the wind.

Excessive Governmental regulations on the private flyer came up for their usual shellacking at an aviation gathering, and it was disclosed that one of the Government surveys on reasons why flyers quit flying came back with enough "write-in" complaints about red-tape, that although this had not been originally listed as one of the causes, it created a sizable percentage in the survey.

Estimates on the post-war plane market quoted, ranged up to one of 166,000 planes for the two years following the war, as "the most optimistic view" while another estimate calculated 39,000 planes would be needed the first year and 16,000 the second. It was generally agreed that any estimate is a wild guess, because of indeterminable factors involved: possible reductions in plane cost due to quantity production and new developments; improved landing facilities for private planes and consequent improved utility; interest stimulated by mass aviation education in the high schools; interest stimulated by training of millions of young Americans in the army and navy air forces, possible reductions in flying hazards, and much-to-be-desired simplification of government flying regulations.

Rigid Airships for Cargo

The large rigid airship was advanced as a logical contender for long-range air cargo hauling on the basis of a comparative study of its characteristics with those of a heavier-than-air cargo plane. Slowness of the dirigible as compared to the plane was described as a virtue, because of the more economical operation of its engines, getting more miles to the gallon, while the dirigible's speed would still be well above the fastest sea surface speeds. Difference in fuel consumption as reflected in amount of payload which could be carried, would be more and more noticeable as the length of the trip increased. A comparison of a rigid airship like the USS Macon, but equipped with modern aircraft engines, against a cargo plane, showed that on a 3000-mile trip the plane would consume more than 50% of its total useful load as fuel while the airship would consume only a little more than 20% while cruising at 60 mph. In other words, the plane could deliver only one ton of cargo for each ton of fuel consumed, while the airship could deliver four tons of cargo for each ton of fuel consumed. Opinion was expressed that the Macon, built more than 10 years ago as an experimental military aircraft would show far less performance than an airship of more modern design taking advantage of the last 10 years' aerodynamic research, and designed especially for air cargo. Among possibilities for improving performance was suggested the installation of a pusher propeller at the stern of the airship.

Engine Parts Studied

With a promise of cheaper aluminum after the war, down to about five cents per lb for secondary grade, in sufficient quantities for additional uses, the prospect of returning aircooled engines from the airplane to the automobile, came to the fore. Price of aluminum castings for cylinders and other engine parts probably will be the deciding factor as to whether the aircooled engines will return to the automobile after 12 years' absence from this country's passenger autos. Importance of low-cost design in both aircraft and automobile engines was stressed, and engineers were urged to find lower cost materials and methods of achieving an equivalent result in engine performance, to further reduce engine production costs. Magnesium is expected to continue largely in use in the aircraft industry, since its cost is not expected to be dropped to a level competing with the secondary aluminum figure.

1944 SAE War Engineering-Annual Meeting

In some aircraft engine parts, synthetic rubber is proving more satisfactory than the natural rubber it replaced, although it is only a substitute in some other uses, it was reported. The synthetic shines in specialized applications where it comes in contact with fuels, lubricating oils, coolants or hydraulic fluids, including parts such as seals, hose, packings, diaphragms and gaskets. Neoprene and Buna N are used in these replacements, while Buna S is substituted in other cases. Faults found sometimes with synthetic rubber parts have been shown under examination to have resulted from faulty part design rather than failure of the material. Some parts are tested at temperatures of minus 70 F and others at temperatures of 300 F while the usual temperature range of operation is from —40 F to 212 F.

Liquid vs. Aircooled

The liquid-cooled engine proponents got in their licks at the meeting with a report that liquid-cooled engines require 22% less horsepower to produce top speed in a given plane than would be required to produce the same speed in an otherwise identical plane with an aircooled engine. The reduction results partly from reduced cooling drag, due to improved radiator shape and location, and partly from reduced fuselage drag obtained through streamlining the plane's nose. The better streamlining comes about as a result of installing the radiator at some point away from the engine, such as the aft part of the fuselage as in the Mustang, or in the wings near the fuselage, as in the British Spitfire. Advantage gained by the streamlining more than compensates for any added weight resulting from the extra feet of "plumbing" between the radiator and engine.

Still another phase of the aircraft engine discussions brought out a summary of causes of civil aircraft engine failures between Jan. 1, 1941, and June 30, 1943. In that period U. S. airlines flew 340,000,000 miles with 3305 engine failures resulting in only seven forced landings, with only three planes damaged and no one hurt — evidence of the high standard of airline engine maintenance, and of the superior safety advantage of twin-engine plane operation over single-engine operation. The advantage showed up more clearly in the corresponding data on some private plane engine failures, showing 2658 failures resulting in 2416 forced landings, 1150 accidents, 1462 planes damaged, 187 persons injured and 36 fatalities. Since only a small percentage of private planes have more than one engine, the conclusion is obvious.

Research Data Asked

Appeals for more flight research (both for testing engines and aircraft structure) were voiced at the meeting to get more complete data on engine performance in actual flight, and to prove effects of flight stresses and strains on various components of the airframe. Discussions brought out the report of a new ground engine testing practice of mounting a complete engine nacelle assembly on a stand with cooling air directed on it from a jet blower to simulate more accurately actual flight conditions. Use of wire strain gages installed at various points about the aircraft structure was also discussed. The gages record the strains measured by electrical impulses to an oscillograph, while the flight test is being made. Many measurements using this technique and equipment are within plus or minus 5% and some within plus or minus 2½% of actual strains. Particularly in the field of extreme speeds where compressibility effects are serious, is this testing-recording technique valuable in substantiating or correcting wind tunnel test results.

Wood Construction Debated

All-wood construction of the British Mosquito fighter-bomber provoked the customary arguments about the merits of wood-construction of airplanes.

Interesting construction details of the Mosquito include: landing gear struts using blocks of rubber as a shock absorber instead of the conventional oleo; bakelite fixtures glued and nailed into openings in wood skin of plane to support instruments at considerable saving in weight over instrument fixtures used in all-metal planes; extremely smooth external surfaces of the plane, obtained by casing external surfaces in fabric, doped, filled and sanded smooth before application of final paint coats; efficient cooling radiators in leading edge of inboard wing, producing almost zero cooling drag at speed; easy field repairs of structure by splicing wood into damaged parts, a job which can be done by almost any journeyman carpenter; continuous wing structure, attached to the fuselage at only four points, two fixed fittings and the other two fittings adjustable in production and in field maintenance. The plane was charactetrized as "extremely fast" with landing speed of about 100 mph, slowed down by flaps. Its powerplants are two Rolls Royce Merlin liquid-cooled V-12 engines, with Canadian built planes using American Packard-built Merlins.

Principal criticism of wood construction, its vulnerability to moisture, is met in the Mosquito's construction by careful attention to ventilation and drainage in design and liberal use of sealer on places where end grain of the wood is exposed.

The well-known airliner, the Douglas DC-3, and its military counterpart, the C-47, formed the focal points of another aircraft structures discussion, centering on design production changes necessary to turn the peacetime plane into a wartime carrier of troops and military cargo. Among changes were: a heavier reinforced floor to carry heavier loads; improved wing tanks, elimination of cabin lining, luxury passenger seats, installation of large cargo door and many minor construction changes. The C-47 seats its paratroopers on benches, which fold back against the walls when not in use, and the military plane at overload has a useful load of 13,200 lb, including fuel, as compared to a useful normal load of 8500 lb for the DC-3. By the time 1000 planes of each type had been built manhours on the 1000th C-47 were almost 30% less than manhours for the 1000th DC-3.

Vapor lock causes and preventive methods were thrashed about in a highly-technical discussion which brought out various means of testing fuel systems, and the consensus of opinion that it was up to the engineers to remedy the stoppages by improved designs of pumps and systems.

AERONAUTICAL SESSIONS

J. G. LEE

S. K. HOFFMAN

Aeronautical topics played a dominant part in the meeting. Seven sessions — three devoted to aircraft engines, three to airframes topics and one to joint engine-airframe considerations — were developed by Vice-President *S. K. Hoffman's* Aircraft-Engine Activity Committee and by *Vice-President J. G. Lee's* Aircraft Activity Committee.

Aircraft engine papers on "Synthetic Rubber Applications on Aircraft Engines" by *Gertrude Spremulli*, of Ranger and on "Difficulties with Engines Installed in Civil Aicraft" by CAA's *S. H. Rolle* were presented at a session chairmanned by *R. W. Young*; on "Aircraft Engine Inlet and Exhaust Porting" by *V. C. Young* of Wilcox-Rich, on "Cooling System Performance of Liquid Cooled Engines" by *C. A. Stamm* and *W. E. McCravey* of Chrysler, and on "A High Altitude Coolant Pump" by *E. T. Vincent*, University of Michigan, at the session at which Mr. Hoffman was chairman; on "Low-Cost Cylinder Design for Commercial Airplane Engines" by *John P. Flannery* of Aircooled Motors and "Aircraft Powerplant Development Testing" by Wright Aeronautical's *J. O. Charshafian* at a session chairmanned by *A. T. Gregory*.

At the joint session, *R. D. Kelly* was chairman, and two papers were given: "Structural Flight Research" by *W. L. Howland* of Lockheed, and "Experimental Flight Testing from the Aircraft Engine Manufacturer's Viewpoint" by *L. C. Miller* of Wright Aeronautical.

Aircraft papers were: "The Post-War Private Airplane" by *W. D. Hall* of Aeronca and "Post-War Private Flying" by CAA's *J. H. Geisse* at a session with *Peter Altman* in the chair. "Mechanical Characteristics of Plain Low Carbon Steel Sheet and Strip" by Illinois Steel's *Dr. H. E. Romine* and "Rational Design of Fastenings" by *E. S. Jenkins* of Curtiss-Wright at a session, *R. G. Bowman* in the chair; and "Production Design Changes in the C-47 Airplane" by *D. L. Moseley* of Douglas, "Transoceanic Air Cargo" by *Lt.-Com. Neil MacCoull*, U. S. Naval Air Station, Lakehurst, N. J., and "All-Weather Flight Methods" by *R. S. Johnson* and *R. D. Kelly* of United Air Lines, presided over by *W. B. Stout*.

All papers presented at this SAE War Engineering-Annual Meeting will appear in a later issue of the SAE Journal, either in full in the Transactions Section or as digests.

Hard Plating and Design Highlight DIESELS

STRANGE aftermath of World War II promises to be dieselization on a scale reminiscent of the expansion of motor-vehicle production and use subsequent to World War I.

U. S. Army discovery 25 years ago that the machine is mightier than the mule has set the stage for history to repeat, although with variations. This time the U. S. Navy is setting the pace, with Army ground and air forces watching every development for possible application to their needs.

Navy Diesel HP Up

In October, 1943, Navy diesels went ahead of steam in volume of horsepower produced. However historic, the total power so produced is a military secret, yet an idea of its proportions may be gleaned from a new Navy project to develop 12,000,000 to 14,000,000 additional diesel power within a year! The project's scope and the minimum time indicate also how greatly diesel mass-production and mass-research have been accelerated by war.

In the light of these developments, Diesel Engine Sessions at the SAE War Engineering-Annual Meeting were Navy's all the way. Engineers applauded Guest Speaker Edward C. Magdeburger, and also Captain L. F. Small, of Navy's Bureau of Ships, for their persistent pre-Pearl Harbor promotion of the diesel cause. To their work was ascribed the inauguration of a Navy diesel research program which, at a cost of something like $400,000,000, resulted in dieselizing the Navy on a scale greater than even they had contemplated and in creating a wartime diesel industry of tremendous proportions.

History appears to be headed for repetition in still other ways. Just as the first few decades of the motor vehicle were marked by birth pains symptomatic of engineering controversy, so engineering opinions painfully are colliding with a severity which sets the diesel's new cradle to rocking. Should diesels be two-cycle or four-cycle? Should diesels be in-line, vee, radial, "porcupine," "quad," "pancake," "diamond," or borrow from geometry some other arrangement to accommodate combinations of two, four, six, eight, 12, 16, 24, and 32 cylinders? What does the future hold for diesel fuels and lubricants?

Future Problems Spotted

It is apparent, however, that sufficient diesel progress has been made—and more will be made during the war—to show diesel engineers in what directions their problems lie. Fuel injection and combustion with high degree of efficiency are among these problems. So is utilization of the ballistic effect of the exhaust, which today is discharged into the wake, but tomorrow may become part of the supercharging system. Torsional vibration and noise are mentioned as serious continuing difficulties. Awaiting completion is the neat little engineering job of reducing weight per horsepower.

Despite all these problems, diesel engineers profess to see on the near side of the horizon a light, efficient, reliable economical packaged-power diesel which will rival the internal-combustion engine—perhaps outstrip it—in enlarging man's capacity for accomplishment, and in universality of application. They insist the war emergency is inspiring diesel engineering talent; tending to transform the diesel from an engine liked for its "lugging" characteristics into a widely useful, highly adaptable package of power.

Said Mr. Magdeburger:

"The process of adapting the diesel engine to mass-production robbed it of its aura of craftsmanship which surrounded the process of assembling and testing a diesel engine only a few years ago. It gained immensely in adaptability. This is a revolutionary process of great importance to the entire industry and will require considerable attention on the part of the heretofore recognized leaders of the diesel industry, because now that the wall of prejudice is broken, the future development will most likely follow an entirely different course. This new adaptability of the diesel engine is manifestly the reason for its magnificent usefulness in this war."

Engine Life Studied

The meeting developed the ideas that an automobile engine and an aircraft engine are both short-lived, and 2000 hr running is quite a lifetime. A large diesel engine, either for marine or for other purposes, is expected to last 30 to 60 times longer. Chrome-plated cylinder barrels were recommended as a direct aid to such longevity and field tests were said to have shown that there are tremendous advantages in using chromium-plated rings. The art of chrome-plating cylinder barrels was described as of prime importance during this war because surfaces so treated show a wear life several times greater than that of metals generally used.

DIESEL-ENGINE SESSIONS

G. C. WILSON

Chromium plating of piston rings and cylinder walls was thoroughly discussed in a symposium on that subject, which formed one of the two sessions arranged by the Diesel-Engine Activity Committee of *Vice-President Grover C. Wilson.*

***Vice-President Wilson* presided at the first session when *E. C. Magdeburger* of the Navy's Bureau of Ships, presented his paper on "Diesel-Engine Design Trends from War Experience of the U. S. Navy," and *R. Bowers* and *R. E. Peterson* of International Harvester presented their paper on "Development of a Single Plunger Injection Pump for a 4-Cyl Diesel Engine." The chairman of the Symposium on "Chromium-Plated Piston Rings and Cylinder Walls" was *G. M. Lange*. A paper on "Porous Chromium for Engine Cylinders" was given by *H. Van der Horst* and *R. Pyles* of the Van der Horst Corp., one by *T. C. Jarrett* of American Hammered Piston Ring on "Some Physical and Wear Characteristics on Porous Chromium-Plated Piston Rings," and a third paper was given by *B. A. Yates* of McQuay-Norris entitled "Summary of Technique of Chrome Plating of Cylinder Barrels."**

All papers presented at this SAE War Engineering-Annual Meeting will appear in a later issue of the SAE Journal either in full in the Transactions Section or as digests.

World-Wide Operations Guide New Research In F & L

WORLD War II is providing a gigantic proving ground for a great civilian technical army which is solving fuels and lubricants problems created by total motorization now, and is preparing the way for satisfactory fuels and lubricants in tomorrow's vehicles of land, sea, and air.

Examples presented at the Fuels and Lubricants Sessions of the SAE War Engineering-Annual Meeting demonstrated that, under the stress of wartime need, progress which normally might occupy decades is accelerated, and from cooperative and coordinated research inspired solutions flow.

Case in point is vapor lock in fuels of aircraft engines and of land combat vehicles, an operating problem which is a hangover from an earlier decade. Motor vehicle engines then showed a disinclination to function continuously on gasoline increased in volatility for purposes of easy starting.

That problem scarcely was so crucial as the difficulties currently experienced with airplanes carrying out military missions at extreme altitudes and under all climatic and weather conditions. In fact, the vapor lock problem was described as encompassing one of the most troublesome operational difficulties of the war. Assigned cause is the formation, somewhere in the fuel system, of vapor which blocks the flow of fuel. Aircraft engine fuel systems appear to be critical, first because they are complicated

1944 SAE War Engineering Annual Meeting

Among the SAE Annual Meeting Dinner Guests Were:

1. Lt.-Col. B. J. Lemon (left), for more than 20 years a member of SAE, now with the Office of the Chief of Ordnance-Detroit, with W. J. Cumming, chief, Maintenance Section, Motor Vehicle Division, Office of Defense Transportation and chairman of the SAE-ODT Coordinating Committee, Col. E. S. Van Deusen, chief of the Transport Vehicle Section, OCO-D, and Lt.-Col. J. H. Frye, Office of the Chief of Ordnance, Washington, and who is an important liaison between the Technical Division of Ordnance and the SAE War Engineering Board

2. A. W. Herrington, former president of the SAE, with Brig.-Gen. W. P. Boatwright, chief, Office of the Chief of Ordnance-Detroit. General Boatwright was one of the five signers of the Ordnance Distinguished Service Award presented to the SAE

3. Lt.-Com. Neil MacCoull, USNR, with Chairman A. G. Herreshoff of the SAE Detroit Section

4. Arthur Nutt, chairman, SAE Aeronautics Division (left), A. W. Lavers, chairman, SAE Tractor War Emergency Committee, and T. A. Boyd, president, Engineering Society of Detroit, Inc.

5. John W. Anderson, secretary, Automotive Council for War Production, with Brig.-Gen. Julian S. Hatcher, chief, Field Service Division, Ordnance Department

6. John H. Hunt, chairman, SAE General Standards Committee, with C. C. Carlton, vice-president, Automotive Council for War Production

and then because, operating at high altitudes in low atmospheric pressures, vapor-forming tendencies of fuel are increased.

Combat vehicles, such as tanks, run headon into the problem because of their maximum operating conditions, loads, periods, and temperatures. Their fuel also is high-octane, readily-vaporizing gasoline, and even their fuel tanks tend to get hot.

At this point the vapor lock problem gets locked in controversy. Is the fuel to blame? Or is the fuel system the basic cause of trouble? Or both? Or what?

In the opinion of R. J. S. Pigott, of Gulf Research & Development Co.:

"This problem has always been capable of concrete solution ever since we have had automobiles . . . For high altitude work (planes) or hot gasoline (tanks), we must . . . cut out all the idiotic resistance we now build into the suction side of the fuel system . . ."

In data compiled from Coordinating Research Council reports by E. W. Aldrich, of National Bureau of Standards; E. M. Barber, of The Texas Co.; A. E. Robertson, of Standard Oil Development Co.; and R. Albright, of Socony-Vacuum Oil Co., it was said:

"It is important to know something about the vapor-forming characteristics of gasolines, the vapor-handling characteristics of fuel systems, and the fuel system conditions that tend to promote vaporization of gasoline."

It was disclosed that out of the work of the civilian technical army has come correlated methods of estimating gasoline's vapor-forming characteristics from customary gasoline inspection data. Further, it was said that, given knowledge of the temperature and pressure characteristics of a given fuel system, the vapor-liquid conditions existing throughout the system can be estimated in those cases where the initial condition of the fuel with respect to air saturation is known.

Attacks upon the vapor lock problem from many different angles were said to have made it already less formidable. For instance, some 90 engineers were reported to have conducted such tests with transport and combat vehicles as to permit of the practical revision of fuel systems by production or field modifications and so, within wide limits, to overcome the difficulty.

Recognition of vapor lock troubles as mutual problems has resulted in assembling a veritable host of experts for coordinated attack from many flanks – hydraulics, engineering, design, fuel characteristics, manufacture, and installation. Further result is avoidance of many of the incidental problems created by failure to recognize difficulties, such as installing pumps which accelerated vapor formation, leading fuel lines through heated areas, or setting up in fuel systems certain elements of resistance to flow which caused bubbles, and therefore, troubles.

Other services of the civilian technical army were described as including work in solving strenuous operating problems occasioned by motorized warfare, in meeting emergency conditions affecting storage and shipment of fuels and lubricants, in combating shortages of critical materials, in simplifying and standardizing military fuels and lubricants requirements, and in serving the need for high speed, intensive technical education for wartime service.

Predictions regarding so-called post-war super-fuels, which were said to produce tremendous combustion pressures, and, for effective use, would require the development of engines too expensive, too heavy, and too noisy for the American public, took this general line:

The public will be interested in lighter, smaller engines. Because of the high stresses, it is doubtful that the high-octane automotive engines can be of less weight unless new materials become available. Should engine designers develop a powerplant for average automobile use capable of satisfactory operation on high-octane fuel, petroleum refiners would be forced to adopt expensive refining methods entailing uneconomical use of the available crude. More practical than high-octane fuels is a practicable, lightweight, automatic variable transmission.

FUELS & LUBRICANTS SESSIONS

W. M. HOLADAY

Vapor lock was thoroughly reviewed in reports of recent investigations at the first of the two sessions organized by *Vice-President W. M. Holaday* and his Fuels and Lubricants Activity Committee. Cutting oils and research got attention at the second session.

***J. M. Campbell* was chairman of the Symposium on Vapor Lock. Papers presented were: "A Study of V/L Characteristics of Motor Gasoline and the Application of Vapor Lock Problems in Land Vehicles (Report of Automotive Vapor-Lock Subcommittee of CRC)," by *E. M. Barber, A. E. Robertson,* and *E. W. Aldrich;* "Cooperative Studies of Fuels and Fuel System Phenomena Contributing to Aviation Vapor & Lock (Report of Aviation Vapor-Lock Subcommittee of CRC)," by *R. Albright* and *A. E. Robertson;* "Vapor Lock, or Dumb Engineering," by *R. J. S. Pigott* of Gulf; "Vapor-Locks Tests on Ordnance Transport and Combat Vehicles," by *W. G. Ainsley,* consultant, Ordnance Dept.; "Altitude Vapor Formation in Aircraft Fuel Systems," by Messrs. *W. H.* and *R. R. Curtis* of Thompson Products.**

***Vice-President Holaday* was chairman of the second session, when *H. L. Moir, J. S. Yule, D. J. Wangelin,* and *R. G. Moyer* of Pure Oil presented their paper on "A Laboratory Method for Evaluating Cutting Oils," and *C. B. Veal,* secretary of CRC, spoke on "Mobilized Research," a progress report of the projects of the joint SAE-API research organization.**

All papers presented at this SAE War Engineering-Annual Meeting will appear in a later issue of the SAE Journal either in full in the Transaction Section or as digests.

TRANSPORTATION & MAINTENANCE SESSIONS

A. M. WOLF

Parts reconditioning and synthetic tires were considered in the two sessions organized by *Vice-President A. M. Wolf's* Transportation and Maintenance Activity.

"Ordnance Keeps 'Em Rolling —What Fleet Men may Learn from Army tests of Synthetic Tires," was discussed by *Lt.-Col. B. J. Lemon* and *Capt. J. J. Robson,* Ordnance Department, at the first session with *Vice-President Wolf* as chairman. *E. W. Templin* was chairman of the second session, when *Norman Hoertz* of Thompson Products gave his paper on "Engine Valve Reclamation," and *J. V. Bassett* spoke on "Reconditioning Brake Drums."

All papers presented at this SAE War Engineering-Annual Meeting will appear in a later issue of the SAE Journal either in full in the Transactions Section or as digests.

T & M *Operating Techniques Shown and Synthesized*

CONVINCING evidence presented at Transportation & Maintenance Sessions of the SAE War Engineering-Annual Meeting led logically and inescapably to conclusions that the wartime experience of keeping Army trucks rolling is developing a service science with ramifications benefiting civilian motor vehicles both now and in the post-war period. The meetings made obvious the fact that motorized war is a proving ground. Armed forces, putting all types of motor vehicles to extremes in operating tests, either for purposes of tactics or observation, are giving both manufacturers and users, as well as engineers, the benefits of rough, tough proof tests which are leaving fewer questions unanswered.

Except for the requirements of military

1944 SAE War Engineering-Annual Meeting

secrecy, the Army was generous with the information. For instance, Army representatives reported fully on Army experiences with synthetic tires. They said frankly that synthetic rubber tires are not as good as natural rubber tires, but that the gap in quality between the two is narrowing. Among their findings:

Synthetics develop higher flexing heat, lose stretchability, chip and crack when hot—but not so badly as Nazi tires. Synthetics have low resistance at higher temperatures. They require more time and power to mill. They stick poorly before vulcanization.

Of major interest to commercial users was the disclosure that synthetic tires just cannot withstand sustained high-speed runs with heavy loads during hot weather.

Army Synthetic Experience

On the credit side of the ledger, synthetic tires were said to serve the Army satisfactorily in travel across country and over poorly maintained roads. Smaller sizes are giving better than 10,000 miles; medium sizes 10,000 to 18,000 miles. Synthetic inner tubes of Butyl have an Army service life of better than 20,000 miles—with the reasonable care which is a fundamental requirement of all synthetics.

Army representatives also reported, after exhaustive tests with motor vehicles in mud, snow, and sand, that large, soft tires are preferable to small, fully-inflated tires. Mud and snow call for aggressive tread design, adequate ground clearance, some deflation. Operations in sand call for tire sizes twice normal, considerable deflation.

Contributing directly to wartime maintenance of both military and civilian vehicles were reports developed from joint SAE-Ordnance studies confirming engineering theory that engine valves can be reclaimed for additional service. It was admitted that the reclaimed valve approximates in cost a new valve, but that the importance of valve reclaiming grows as the supply of new valves shrinks.

Reclaiming valves which show no serious burning or guttering has become a routine job of regrinding seats and tips. Valves guttered, pounded, or burned to the point where refacing produces knife edges, and valves having deeply burned areas, gutters, and cracks, are reclaimed by adding metal. Reclaiming valves with worn stems is another, but easier, job of adding metal.

Reclaimed Valves Tested

It was explained that tests have been adequate to support definite recommendations for all valve reclamation jobs, but that temporary relief is assured in the larger field of burned, guttered, and cracked valves. Special techniques are developing for grooving seats before applying new metal. Methods of filling cracks and of replacing burned areas are under test. Such jobs may require 27 min of welding and 10 in. of 3-16 in. welding rod, plus time for inspection, cleaning, and grinding.

Similar reports on brake drum reclamation were equally optimistic. In this case also the cost of reclamation approaches that of a new drum, but it was suggested that one unanswered question is whether a new drum, even if available, would be much, if any, better.

Efforts are being concentrated on developing the technique of metal spraying, such methods as sleeving drums, and puddling or centrifugally casting new brake tracks, having been discarded for lack of manpower. Brakes reclaimed by metal spraying are subject to fairly rapid heat-checking. Lining wear is rapid under severe conditions. However, the drums perform well in service, approximate new drums in longevity.

Dynamometer tests, approaching destruction, were said to have proved that sprayed metal applied to a drum preheated to 350 deg after fuse-bond preparation, will not loosen at the bond in service. Field tests show that, on light and medium trucks, sprayed drums give normal performance.

Best spraying material was described as 0.08 carbon wire. Application of a light coat of copper prior to spraying was said to be effective in reducing the formation of heat checks, as also is application of graphitic carbon in conjunction with a wetting agent.

Close to maintenance, and particularly helpful in the post-war period, were reports on the growing importance motor vehicle operators are placing upon design for accessibility. Indicating further improvements also were reports that newly-developed methods of chrome-plating cylinder walls promise to multiply engine operating life, and that field tests have produced evidence that both cylinder and ring wear is reduced by chrome-plating top piston rings.

Production *Session Stresses Quality Controls*

FOCAL point of primary interest to production engineers at the SAE War Engineering-Annual Meeting were quality control through statistical method, production control through tests, and a wide assortment of papers and discussions about materials and their specifications.

Frequently expressed was the opinion that within the past two years more than a decade of technical developments, under normal peacetime rates of progress, had been achieved, and new conceptions of specifications as a manufacturing tool had been born. Full cooperation of all phases of production technology was cited as the primary reason for this. Reviewed in the light of recent developments in some of our major production factories, for example, was the presentation of the mathematical background of statistical theory leading to a Quality Control Chart and an exposition of this as an additional tool for production engineers. New routes to specifications thinking were charted in broad outlines by leaders of SAE specifications projects, most of whom were present at several sessions.

As important as are sound design, careful choice of materials, heat-treatment techniques and controls, and each step of manufacturing and assembly, the ultimate working life of mechanisms depends upon how much the man with a wrench tightens the nuts and stud bolts. Based upon extensive research of the SAE War Engineering Board on Torquing of Nuts in Aircraft Engines, production engineers were given an insight into vast opportunities of strengthening machines by proper distribution of loads and stresses on metals.

Wartime developments in low-alloy high-tensile steels did not prove to be a production man's nightmare, as had been rather freely predicted two years ago. Heat-treating controls must be more accurate than with the richer alloyed steels. Machining and finishing techniques must be revised to serve the more finicky requirements of these alloy-saving materials, production engineers were warned.

Metallurgists handed down a unanimous decision: "To get the best welds, design for welding." A star in the drama of armament production, the low-alloy steels have some of the flighty characteristics of a prima donna, audiences were told.

Further research and test work on cutting oils have emphasized the need of more careful selection of cutting oils to speed armament output. Machine tools, loaded to capacity by heavy backlogs of unfinished weapons, can find relief through the use of cutting oils compounded to best serve both the work and the tool.

Plastics Manufacture

The role of rubber pressure blankets, felt-hat-making machinery, and low-pressure presses was dramatically portrayed by several plastic speakers who reported hundreds of short cuts and cost reductions forced upon the automotive industry by materials shortages of 18 months ago. A veteran production engineer left one of the sessions with this awestruck remark: "It looks as though some of us have been spending most of our lives doing things the hard way," in commenting upon the extreme simplicity of manufacturing some of the non-metallic materials which may be here to stay.

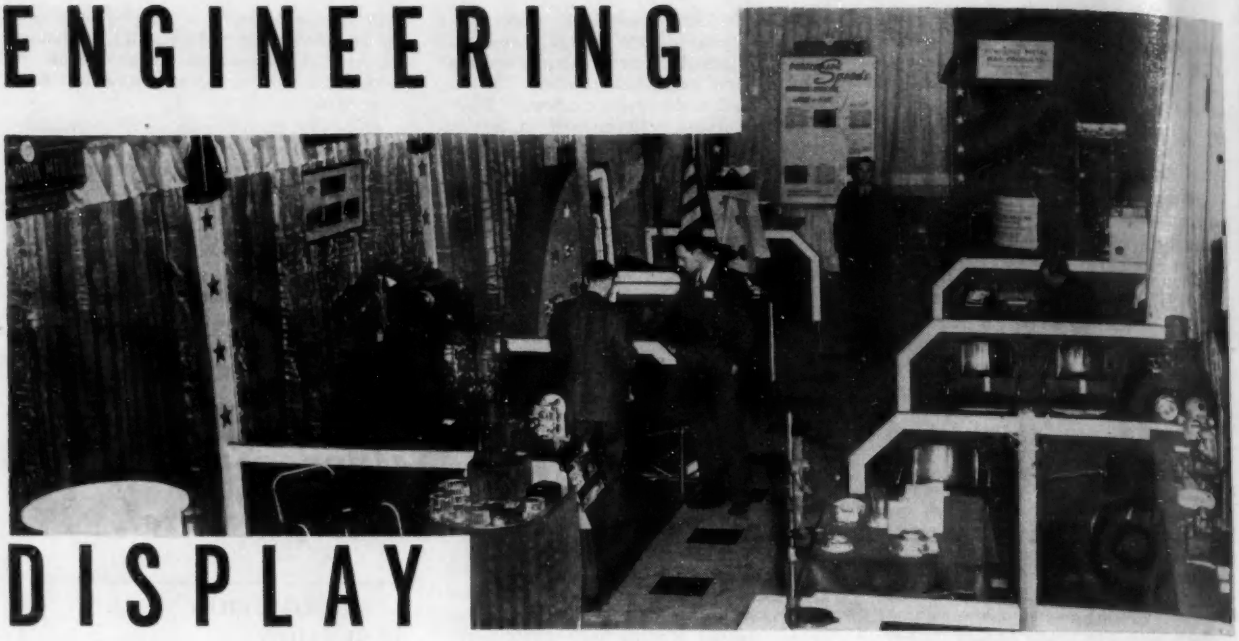
PRODUCTION SESSION

ARNOLD LENZ

One session was organized by *Vice-President Arnold* Lenz and his Production Activity Committee. Mr. Lenz was chairman of this session when *John Gaillard*, of the American Standards Association, spoke on "Getting a Better Grip on Quality Control."

All papers presented at this SAE War Engineering-Annual Meeting will appear in a later issue of the SAE Journal either in full in the Transactions Section or as digests.

ENGINEERING DISPLAY



WITHIN the limitations of security of the national defense, 36 exhibitors showed more than 100 interesting items of automotive engineering developments at the eleventh consecutive SAE Annual Engineering Display, which opened Jan. 10 at the Book-Cadillac Hotel.

The exhibit continued throughout the 1944 SAE War Engineering-Annual Meeting, which ended Jan. 14.

ADEL PRECISION PRODUCTS CORP. Operation of Isodraulic control, a newly developed type of hydraulic remote position control having applications in many fields was demonstrated on a model airplane. Propeller speed, the landing gear and its doors were each remotely controlled with one of these units. The Adel "Micronic" filter was also displayed in a small and a large size. The large model, designed for use with hydraulic oil, takes 30 gal per min at 100 F, with a 16-oz pressure drop. Dirt particles only 5 microns in diameter are said to be stopped by this filter. Solenoid valves of several types, an anti-icer pump and various types of valves were among their other products on exhibit.

AEROQUIP CORP. Newest development of the company shown was their hydraulic fuse by which any one of several hydraulic controls is automatically cut off, protecting the other units and losing only a small amount of the hydraulic fluid. An operating demonstration had been installed to show the scheme of the fuse. The mechanism was enclosed in a transparent plastic housing so that the action of the pistons and valves in the fuse was plainly visible. The company's self-sealing coupling and detachable tube fitting, both widely used in the aircraft industry, were also shown.

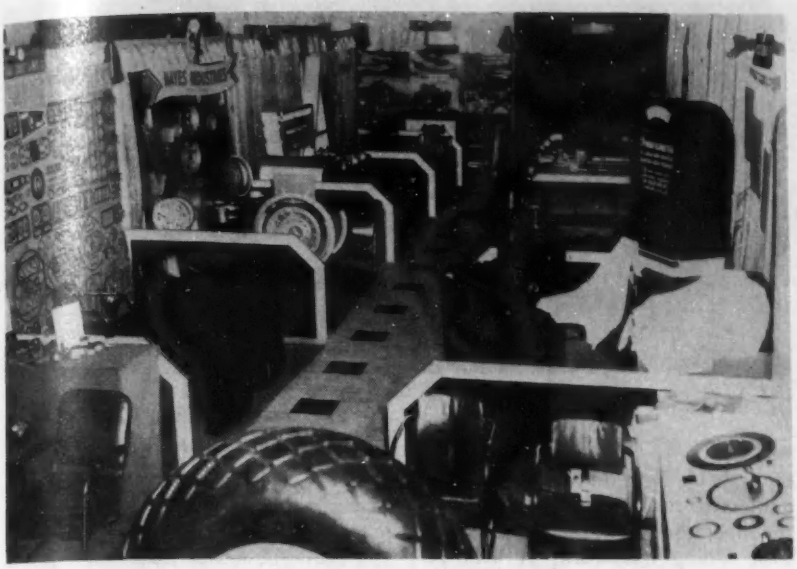
AIRCRAFT SCREW PRODUCTS CO., INC. How fatigue resistance can be doubled in aircraft screw applications was shown in an elaborate exhibit of the developments of this company. A bronze or drawn stainless steel wire, coiled and fitted between mating threaded parts, both of which are equipped with a special thread developed by this concern, was shown to be the answer to excessive fatigue. The "Heli-coil" bushing for spark plugs was also demonstrated. The hole is tapped for the special thread, the coiled steel wire bushing is inserted, and fitted with a standard SAE plug.

ALUMINUM CO. OF AMERICA. A saving of 175 lb can be made on a standard automobile engine by using aluminum connecting rods, cylinder block and crankcase, cylinder head, intake manifold, timing chain case, water pump housing, clutch housing, and the transmission case. Such an engine was shown as one of the exhibits of this company, being a 6-cyl engine of 216 cu in. displacement, which develops about 85 hp. Special emphasis was laid upon newly developed manufacturing methods of both aluminum and magnesium. The Mazlo products of the American Magnesium Corp. were also displayed. Recommended methods of welding and brazing were shown. Included among the parts shown were timing gears, housings, and aircraft wheels.

ALUMINUM INDUSTRIES, INC. Versatility of aluminum magnesium and aluminum alloys in permanent-mold and sand castings was shown in a wide range of parts cast with varying sections. Parts included a carburetor throttle body, flanged fittings of a wide range of dimensions, pipe with flanges, and brackets.

AMERICAN BOSCH CORP. Injection pumps and a variety of spray nozzles for use with diesel fuel and one pump for operation with gasoline were shown, along with many models of generators, voltage regulators, and aviation magnetos. Operation of an induction vibrator was demonstrated. These vibrators are designed for use as an auxiliary source of ignition to facilitate starting of aircraft engines. They provide a simple means of obtaining a shower of sparks for starting purposes, for they are operated simply by turning on the ignition switch and engaging the starter.

BLACK DRILL CO. Reamers and drills, developed to give extreme edge hardness without disturbing the resistance of the tool to abrasion, were shown by this company, together with a demonstration of drilling and reaming. This development precludes the replacement of reamers of high speed steel where long production life and control of accurate hole size is required. Bits for rough hog-



ging cuts on tough alloy steels were also shown. Recommended drill speeds are from 600 rpm for the ⅞ to 1 in. sizes to 3000 rpm for the ⅛ in. drills, without coolants.

CITIES SERVICE OIL CO. (Petroleum Advisors, Inc.) An improved flight and laboratory exhaust gas analyzer, which makes readings over the whole range of mixtures from extremely lean to rich, was shown. A new line of lubricants, synthesized for extreme low and others for high-temperature operations was shown as well as both immersion type and unit heaters for oil. The latter is used in the PT boats of the Navy.

CRANE PACKING CO. Simplicity is well illustrated in the pump seal offered by Crane. Made up of only two parts – bellows and spring, assembled as a unit – this seal is installed partially compressed, ready for instant sealing. Because of its ability to flex and compress as a unit, pressure variation, misalignment, torque, or vibration set up by an unbalanced impeller is automatically compensated for.

CLEVELAND GRAPHITE BRONZE CO. put special emphasis on its 3000-psi pressure bearing being developed for post-war automobile use. This bearing consists of a steel backing, an inner layer of copper-lead alloy 0.014 in. thick, and a 0.001-in. surface plate of a lead-tin alloy. Bearings, large and small, and for a large variety of applications, using either a copper-lead alloy or a lead babbitt as the bearing surface were also shown.

CONTINENTAL MOTORS CORP. A 7-cyl radial aircooled engine, rated at 250 hp at 2400 rpm which is widely used in light tanks, was exhibited. It is compact and of light weight, and produces its rated output on 80-octane fuel. It has been on many of the major battle fronts, particularly in the M-3A1 and M-3A3 types.

DE LUXE PRODUCTS CORP., INC. Shown for the first time to the public, the copper deck piston permits closer fits, higher heats and greater pressures than conventional types of cast-iron units. The manufacturer also showed the "Clearex," an exhaust device for emitting air into the combustion chamber which eliminates fouling of plugs and carbon accumulations. The company's line of oil filters was also shown.

DETROIT GASKET & MFG. CO. Stemming from intensified research on synthetic materials for gaskets beginning in 1934, the company has been able to meet materials shortages time and again by being ready for successive limitations with adequate, and sometimes better, substitutes. The steel-asbestos units, plastics, cork, and a new material composed of neither asbestos nor vegetable fiber, were shown on a large board indicating the wide range of materials and sizes.

EX-CELL-O CORP. Cutaway models of diesel fuel injection pumps developed by the company, and an installation of one of the units on a Chrysler diesel marine 6-cyl engine, were displayed. The pump is a self-contained assembly of units consisting of hydraulic, accelerator, control, and transfer pump units, mounted on a drive unit arranged for flange mounting on the engine. This system allows servicing by the use of replaceable unit assemblies.

FLEX-O-TUBE CO. had a wide variety of its hose assemblies for hydraulic, oil, air, and instrument lines on display. These hoses are showing good service on such airplanes as the Martin "PBM" and the Curtis Helldiver. Hose assemblies and fittings are also available for automotive and industrial applications.

FRAM CORP. Operation of a Fram oil filter installed in a simulated engine lubrication system was shown, demonstrating the effectiveness of the filter in reducing contamination and cleaning the lubricant. Part of the black, contaminated oil from the sump was put through the filter, and part was bypassed. The clear oil from the filter and the black bypassed lubricant served to show the comparison of filtered and unfiltered oil.

GARLOCK PACKING CO. Showed only a few samples from its large line of ring and other types of packings, gaskets, and oil seals, due to wartime restrictions. The company noted, though, that there is hardly one piece of mobile war equipment that does not have at least one Garlock unit in some assembly.

GEMMER MFG. CO. Newest application of the shock-arresting steering gear as shown in the display is for military vehicles designed for heavy-duty, off the highway work. The development incorporates a locking bar mounted in an extension of the lower worm bearing cup. The bar turns freely in a ring when actuated by the steering wheel. It then locks when the steering or pitman arm becomes the driving force.

HAYES INDUSTRIES, INC. A cutaway showing the expander tube hydraulic brake actuating mechanism was shown to explain the large brake area achieved in this design for aircraft landing wheels. Braking is furnished in each direction with the minimum total weight of the unit. The design provides braking effect, even though the drums become eccen-

tric or out of round. In addition, units of various sizes were displayed, with cutaways to show the actuating mechanism.

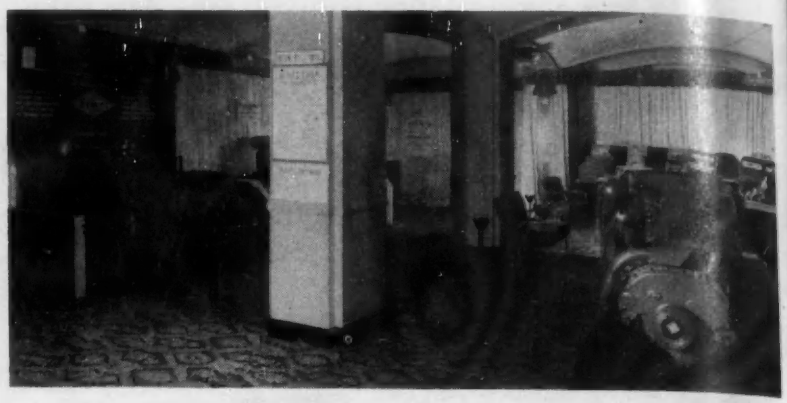
HERCULES MOTORS CORP. A 6-cyl diesel marine engine, with built-in supercharger, was displayed. Because of Navy restrictions, the powerplant could not be described in fuller detail.

KOPPERS CO., American Hammered Piston Ring Division. Newest development of the company is an improved high tensile cast iron for piston rings, currently being used exclusively for aircraft because of its relative scarcity. Porous chrome plating for piston rings provides pores for retaining oil and thus improving the effect of any lubricant. The display was mounted on a red, white, and blue panel which showed, through a revolving circular transparency, the firm's large plant for chrome plating of piston rings.

LORD MFG. CO. Applications of the "Dynafocal" shear-type rubber mountings for aircraft-engine installation were shown in the display, as well as a wide range of other automotive and industrial uses of bonded rubber-to-metal units. An aircraft instrument panel mounted on a vibrating table showed the extent to which vibrations can be kept from the delicate instruments by use of properly designed rubber mountings.

MONROE AUTO EQUIPMENT CO. Interesting development is a method of electroplating copper, chromium, silver, gold, and other metals on plastics, metal-plated car door handles and other small parts were shown. Elimination of the corrosion problem is of outstanding importance. Hydraulic controls for aircraft flaps, bomb bay doors, and preselectors for landing gear retraction also were shown, together with a wide range of shock absorbers used on vehicles in size from motorcycles to railroad cars. These designs were developed through the Army.

PHYSICISTS RESEARCH CO. New attachments to the profilometers of



the company were displayed. The equipment, light in weight and conveniently packed for handlings by the operator, is widely used in factories doing war work. A wide line of attachments, several of which are new, have been added to handle special inspection work where the usual profilometer cannot be used.

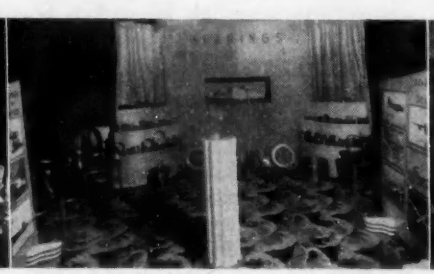
REMINGTON RAND, INC. To speed war work by accelerating copying of blueprints, specifications, orders, and other documents, the company showed its complete line of photocopying machines. The unit shown will handle prints up to 32 x 45 in. in size. Small portable machines for office use as well as continuous types, for reproducing prints of any length with a maximum width of 42 in. Direct copying from blueprints, pencil drawings, letters, and photographs can be done.

SPICER MFG. CORP. The Army's 895 axle, with the gear cover removed, was shown. This tractor unit, weighing about 3000 lb, is used on a number of types of vehicles. A small universal joint, used on the Bell Aircobra propeller drive, sufficiently compact to be located under the pilot's seat, is made from nickel-chrome steel, and each part is thoroughly magnafluxed in inspection. A larger universal joint, currently used in amphibious vehicles, and a power takeoff unit for Army truck winches, were also displayed.

STEWART-WARNER CORP. A light, compact heater, driven by a small electric motor, for use in the passenger compartment of motor vehicles, a ram-type heater for airplane cabins, and a hand-cranked heater for heat applications to carburetors or other engine parts were featured. The exhibit was rounded out with models of a few of the company's other products, including Alemite lubrication handguns and fittings, automotive instruments and instrument panels.

TINNERMAN PRODUCTS, INC. Speed nuts, speed clips, and shop nuts now have an almost infinite number of applications, a small percentage of which was on display in the parlor space occupied by this company. Aircraft applications alone are numbered in the hundreds, although speed nuts are also widely used in tanks, trucks, jeeps, communication equipment, and many other war products. Special speed nuts are even made for use in plywood. Designed with two pairs of integrally formed attaching legs, the nut can instantly be driven into anchored position, regardless of whether the plywood is thick or thin.

TORRINGTON MFG. CO. Builders of blower wheels and fan blades, displayed various sizes of its products. Quiet operation, ruggedness of construction, and lightness are embodied in these air impellers. Fan blades 3 to 48 in. in diameter are made for



desk fans, evaporative coolers, air conditioners, ventilators, windshield defrosters, and general pressure uses. Blower wheels from 3 to 16 in. diameter of both steel and aluminum are made for a wide number of appliances.

TRUCK EQUIPMENT CO., INC. Realistic demonstration of the operation of the gravity spring tandem axle suspension was given by the operation of model cars equipped with this type of suspension on a very bumpy model roadway. The unit is light in weight, extremely flexible, vertically and laterally, and provides automatic steering and automatic axle alignment.

TUBING SEAL-CAP, INC., exhibited its torq-snap wrenches, which are designed to give a pre-determined torque load even when used in very difficult positions. Each wrench is pre-set to its proper load for the nut that it is designed to fit. When this load is reached, the wrench gives a definite audible click and a small tickler taps the operator's hand, thus the wrench can be used in the dark or in noisy places. Applications of the company's other products were shown, including sealing plugs, for the ends of tubing with threaded fittings; seal caps for threaded male fittings; flex-caps, for protecting plain end and beaded tubing and pipe; and boss plugs, for threaded flush openings in hydraulic and other units.

VICTOR MFG. & GASKET CO. Oil seals for shafts ranging from 5/16 to 12 in. diameter, making use of the synthetic rubber Victoprene, are made by this company. A seal of this type 11 in. in diameter has been developed for the ball joint of a large armored truck front axle. This oil seal prevents loss of the thin oil used in the front drive joint of the axle. Also shown was the line of gaskets for cylinder heads and many other applications.

WAUKESHA MOTOR CO. Stemming from power units developed for air conditioning passenger-car trains, refrigerating box cars, and augmenting the electrical power of trains, a lightweight 7½-kw engine generator has been produced for military bombers weighing only 380 lb, skid mounted and complete. All castings are of aluminum alloy. Cylinder block is separate from the crankcase. Cylinders are of dry-sleeve type.

WELKER MACHINERY CO., INC. Distributors for a wide line of manufacturing equipment, the firm showed a new adaptation of the Deepfreeze (Motor Products Corp.) which shrinks valve seat inserts on the Dodge engine. A new use of the unit is to harden cutting tools. Several hundred per cent increase of tool life has been demonstrated. Powdered metal parts have come a long way from the earlier bushings to complicated parts, as shown in an exhibit of Super-Oilite oil cushion bearings by the Amplex Division of Chrysler Corp. Tocco hardening equipment, also handled by the Welker firm, and a lapping machine were shown.

S. K. WELLMAN CO. Velvetouch friction material, a combination of sintered powdered metals, compressed and welded to a solid metal backing was shown applied to many types of clutch facings and brake linings. Since this friction material is all metal, it is not affected by heat, oil, or moisture. It finds use in heavy-duty applications on earth-moving equipment, trucks, buses, airplanes, and in marine and textile equipment.

ZOLLNER MACHINE WORKS displayed posters explaining that its wartime output of heavy-duty pistons is being entirely devoted to such military uses as tanks, airplanes, marine uses, and transports. During peacetime, their pistons were original equipment on many gasoline; carbureted oil, solid-injection spark-ignition, and diesel engines, for use on automobiles, motor boats, trucks, buses, and other motor vehicles.

Ordnance DSA to SAE

continued from p. 21

the results obtained as a combination of the trust which Ordnance has given to the Society and the unwavering determination of SAE members to pool *all* their knowledge and experience without reserve in the service of the nation.

The award was authorized Dec. 28, 1943, and carries the signatures of five Ordnance Generals, headed by Major-Gen. Levin H. Campbell, chief of Ordnance. Other signators are: Major-Gen. Barnes; Major-Gen. T. J. Hayes, chief Industrial Division; Brig.-Gen. W. P. Boatwright, chief, Office of Chief of Ordnance, Detroit (formerly Tank-Automotive Center).

Through the cooperative work of SAE committees, Gen. Barnes said in presenting the Award, "the Ordnance Department was able to keep its designs of tanks and armored fighting vehicles in step with the progress being made in the commercial engineering field. Thus, when the war emergency arose, the Department was able immediately to place its tanks and armored fighting vehicles under quantity production without delay. . . ."

Marking the vast extension of the SAE War Program since 1939, Gen. Barnes continued:

"These committees have handled more than 1000 projects for the Army and Navy, most of which have been at the request of the Ordnance Department. As a result of this work, more than 600 reports have been completed, including conclusions and recommendations pertaining entirely to war effort. . . .

"The Ordnance Department sincerely hopes that the SAE, through its committee system, will continue in this important work of helping the Ordnance Department throughout the duration of war. Looking to the future we also sincerely hope that the Society will continue its contribution along these lines in the post-war period."

Past-President A. T. Colwell (left) receives from Mac Short a certificate of Life Membership in the Society of Automotive Engineers.

Photographed by Merrell Wood

★ ★ ★ Briefed from Papers Given at

Technical IDEAS

ROBOT INSTRUMENTS FOR PLANES EVOLVE

Seek Simplified, Reliable, Automatic Guides to Lessen Pilots' Many Duties

by F. G. NESBITT
Chief of Gyro Unit, Wright Field

▪ **Cleveland, Dec. 13**

(Excerpts from a paper entitled "Aircraft Instruments")

AIRCRAFT instruments which make possible the operation of aircraft may be divided into four classes: (1) Power instruments, which relate to the motive power of flight and for the continuation of that motive power for pre-determined periods; (2) Flight instruments, which relate to the attitude, speed and height of aircraft. There are rate instruments, composed of air-speed indicator, bank-and-turn indicator and rate-of-climb indicator and amount instruments, made up of altimeter, gyro horizon and directional gyro; (3) Navigation instruments, which permit the navigation of aircraft from a point of departure to a preselected destination, and (4) Safety instruments.

Future flight instruments will probably be different from the combination now used. The airspeed indicator and altimeter will undoubtedly be retained, but the remaining flight instruments will take another form. The ideal such instrument will be one which presents a picture to the pilot which will permit him to fly under instrument conditions as easily as he does in clear weather by visual reference with the real horizon. At present, however, it takes hours of practice for a pilot to become proficient in instrument flying with rate- and amount-type instruments. The development of a single flight instrument of reliability and freedom from upset in extreme maneuvers will replace the types in general use now.

The future trend in the development of navigation instruments will include further improvement in the accuracy and performance of the remote indicating compass. A remote compass which indicates magnetic heading in a dead-beat manner without turning errors or oscillation can replace the directional gyro in the flight instrument group and thereby serve two functions. This development is being approached in two ways. First, the magnetic compass element can be stabilized by a gyro, which will always read a heading in a horizontal plane regardless of whether or not the airplane is turning. The second way is to control the directional gyro in azimuth by an unstabilized compass unit located in a part of the airplane which is free from magnetic interference. This overcomes the main objection to the directional gyro, namely, that it has to be reset periodically and at the same time, producing a dead-beat indication of magnetic heading. Further experience will indicate which of these two methods is best.

turn to p. 52

TRAILER

Maintenance Calls for Thorough Checking Job

by JOHN N. BAIRD
Utility Trailer Sales Co.

▪ **Northern California, Dec. 13**

(Excerpts from paper entitled "Heavy-Duty Trailer Maintenance")

HEAVY-duty trailer maintenance may be divided into the following classes:

LUBRICATION – The fault in maintenance has been to locate and service all lubrication points. Wheel bearings are given the necessary periodic attention, but the trailer chassis contains many fittings which are hard to find. The recommended lubrication period for chassis fittings is 1000 miles or weekly. For wheel bearings it is 10,000 miles or monthly. It is advisable that a complete repacking job be done to preclude the danger of mixing greases whose respective lubrication values might be nullified by a chemical reaction.

FRAMES – We use a non-heat-treated type of frame, chromium, nickel, copper alloy in the I-beam shape, known as Mayari beam. Heat may be applied without loss of original properties. Section modulus and moment of inertia may be radically augmented by overlaying one or both flanges by straps and by plating one side of the web. In the 10-in. joist shape, for instance, a ¼-in. plate 9 in. deep increases section modulus from 10.5 to 13.4 and moment of inertia from 51.8 to 67.0. Strapping both flanges ¼ x 4 in. increases section modulus from 10.5 to 19.9 and moment of inertia from 51.8 to 104.4. Thus, strapping increases strength about 100% while plating only increases it 33%. Semi-trailer frames of maximum legal length, 35 ft, should be trussed rather than bottom strapped, using flat steel and 4-in. pipe spreaders.

In adding steel to a frame care must be taken not to intensify stresses by ending the reinforcing member too abruptly. Plating should end on a diagonal; strapping should be run out to a point. A bottom strap should extend 10 to 12 in. longer than the top.

RUNNING GEAR – Careful maintenance of springs, clip-bolts, and brakes is more than ever essential. Proof of proper adjustment of trailer brakes, which are usually of the S-cam type with shoes adjustable at both cam and anchor ends, is uniform heating of all brakes on application.

Drums, which fail more from bad driving practice than from inferior analysis or design, may be reconditioned successfully any number of times, resulting in an extension of their useful life by as much as 80%, so long as the total metal removed does not exceed 25% of the new drum thickness. When brakes are relined, drum surface should always be checked and if grooves or roughness to a depth of 1/16 in. are present, the drum should be turned. When this is done, either an oversize cam roller or lining shims should be installed. If drum has to be replaced, a new drum should be bolted to the hub and turned so that the brake surface is concentric with hub and spindle.

FIFTH WHEELS – Those used in semi-

COLD AFFECTS DIESEL FUELS

by R. WAYNE GOODALE
Standard Oil Co. of Calif.

▪ **Northern California, Dec. 13**

(Excerpts from paper entitled "Operating Automotive Equipment at —50 F")

DIESEL FUELS – In view of practices followed in civilian life, large quantities of fuels supplied to Alaska for use in diesel engines, pot-type heaters, and burners, had a pour point of only 0 F. Due to the low temperatures, heater and burner problems involved either the flooding of stoves resulting in serious fires, or the starvation of stoves. High pour point fuel was unsatisfactory due to plugging of screens and filters with wax. Tests determined that at temperatures involved cetane number is of minor importance and low pour point is the most important single requirement of a diesel fuel supplied to Alaska.

GASOLINE – Gasoline was found satisfactory if, at extremely low temperatures, auxiliary heat or starting aids were used to start the engines.

STANDARD BAN-ICE – A common problem that existed in gasoline and diesel fuel systems was ice that formed in fuel tanks, due to the fact that fuels will dissolve about 0.005% water. To overcome this, Standard-Ban-Ice has been developed, which, when

at SAE SECTION MEETINGS ★ ★ ★

...for ENGINEERS

trailers must be classified with landing gear of the automatic type. Those in full trailers have minimized the maintenance problem tremendously since the era of the knuckle steer, which retarded the use of trailers for years because of the ungovernable tendency toward whipping. However, it is still possible for whipping to develop, which is caused by undue friction of the fifth wheel itself. Maintenance should be aimed at free action of the fifth wheel, since any binding tendency impairs the proper control of trailer by the towing vehicle. Coupler bars, another cause of whipping, must be kept tight at their hinge points.

ALIGNMENT – Misalignment causes more tire waste than all other deficiencies in maintenance combined. In trailers not equipped with radius rods, misalignment may result from a broken spring center bolt, which is usually caused by loose clip bolts. In units equipped with radius rods, misalignment may be due to an improper setting of eccentric pins or other adjustment provision or to the need for bushing replacement.

Misalignment is often found in trailers with bent frames, or in those whose frames have been worked on in any way.

Axle camber should be checked simultaneously with alignment. Alignment checking must start from king pin to determine that this is centered accurately in the frame. Front axle is then aligned by checking the distance from pintle eye to both ends of the front axle. Rear axle should then be aligned with front axle. In the case of dual axle rear end, the first of the two rear axles

turn to p. 53

Oil Filters Essential To Engine Maintenance

by W. G. NOSTRAND and L. L. MOORE
Winslow Engineering Co.

▪ **Northern California, Dec. 13**

(Excerpts from paper entitled "The Necessity of Oil Filters in Preventive Maintenance")

THE importance and necessity of oil filters in correct servicing of the lubricating system is evidenced in the following results:

1. Reduced engine wear – an oil filter-equipped engine, due to the removal from the oil of dirt, gum, varnish, and acids, prolongs the lives of such parts as pistons, piston rings, piston pins, piston pin bearings, connecting rod bearings, crankshafts, valves, valve guides, valve seats as well as the clutch, transmission, and tires.

2. Lengthened engine overhaul periods – which is the natural result of decreased wear on critical engine parts. It enables a fleet to "get by" with less manpower and fewer pieces of equipment. Less frequent oil changes are required since dirt, sludge, varnish, carbon and metal particles are removed

turn to next page

used in proportions of a fraction of 1%, is effective in preventing the freezing of water down to —50 to —60 F. Fig. 1 shows the proportions required for lowering the freezing point of the entrained water to the desired temperature.

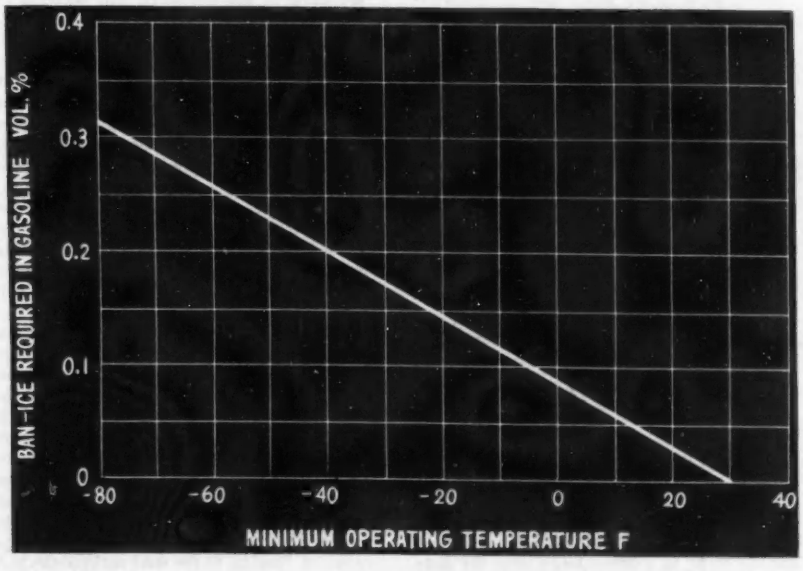
CRANKCASE OILS – The difficulty with this oil can be attributed to too high a viscosity to permit cranking of the engine, and to too high a pour point to permit fluid flow at the temperatures involved. Two courses that may avoid the difficulties are: dilute SAE 10 oils with gasoline or develop an oil of lower viscosity than SAE 10. In order to select the most suitable method for overcoming the difficulties, temperature histories were obtained on vehicles operated at temperatures as low as —44. Coolant and crankcase oil attained levels approaching those experienced in service at high atmospheric temperatures due to the thermostatic control of the jacket. Thus, it was decided, rather than follow the two courses above-mentioned, that the practice as followed by military aircraft of diluting engine oils with gasoline prior to shutting down be followed by ground equipment also. This requires less diluent to reduce the viscosity and pour point to the desired values, and also the gasoline will evaporate after starting and the engine will operate on the original grade of lubricant after it has warmed up. To prevent excessive evaporation of the gasoline the engine should be idled a few minutes to permit the oil to cool before adding the diluent.

GEAR LUBRICANTS – A gear lubricant lighter than SAE 80 but one with extreme-pressure characteristics to keep gear case warm was developed and is now distributed throughout the North:

Hypoid-Lubricant Subzero Type	
Viscosity at 100 F, SSU	81
Temperature at Which Viscosity Is 100,000 SSU, F	-55
Pour Point, F	-55
Channel Point, F	-65
Load-Carrying Capacity, SAE Machine, 1000 rpm	300
Foaming	None
Turbidity	None

CHASSIS AND WHEEL BEARING GREASE – These parts experienced the same problem of being inadequately warmed as the gear cases. A No. 00 grease was developed that had outstanding low temperature plasticity characteristics and sufficient extreme pressure properties to make it an all-purpose grease for use in wheel and chassis bearings.

turn to page 52



Per cent Standard Ban-Ice required to prevent freezing of water in gasoline-water-ban-ice mixtures

from the oil. By keeping rings free, dilution is also cut down.

3. Reduced oil consumption – piston ring grooves are kept free of gum, varnish, and carbon. Both gasoline and diesel fuel can be saved since critical parts, such as valves, perform more efficiently when lubricated with a clean oil. While we are stressing a saving of critical parts and manpower, economical operation must inevitably follow.

4. Easier overhaul jobs resulting from the fact that the mechanic works with parts not coated with sludge, which saves him time of cleaning the engine.

Installations Are Critical

While oil filters are generally accepted as an effective means of preventive maintenance, improper installation or operation can neutralize any possible benefits. Proper operation simply means the establishing and abiding by certain periodic oil and element changes. It might be noted that the accessibility of the filter and ease with which elements are changed can do much in persuading a mechanic to do the job required.

Periodic oil and element changes are determined by the type and size of filters used, equipment being operated, type of operation, oil being used and climatic conditions encountered.

In considering the type of operation, nothing can be tougher on a filter or engine than continual starting and stopping of the engine. This results in a cold engine, thereby giving high dilution. Dilution usually ends up with sludge and sludge ends up in the filter. Long runs with few stops keeps the engine hot, which evaporates any traces of dilution and evacuates it through the breather.

Period between element changes is governed by the combination of these conditions. The useful life of a straight mineral oil can generally be extended by a greater percentage of time than a compounded oil, since compounds are used up in performing their various duties. If compounded oils are being used, care must be taken that the filter being used does not remove these additives. Laboratory analysis is required as these oils are dark in color, even though clean.

Large Filters Preferred

The size of the filter used will control both element and oil life. The larger the filter, the better the results. Installations of undersize units are of questionable value.

Reporting experiences with oil filters, one large fleet operating on long, hot runs changes elements every 10,000 miles. If the oil turns dark before this period, the vehicle is thoroughly checked. Diesel equipment runs 3,000 miles per element change. Another concern said, "We operate vehicles 200,000 miles and more since using filters, as compared to 60,000-100,000 miles without filters."

Robot Instruments For Planes Evolve

continued from p. 50

One of the outstanding objectives in further development of aircraft instruments is improvement in reliability, and the most reliable instrument, in general, is the simplest instrument. It must be capable of doing its duty under extremely high and low temperatures. It must also be sufficiently sealed and protected against high humidity, sand and dust. Electrically-driven gyro instruments may supersede air-driven ones for this reason. If an instrument must fail, the design should be such that when it fails it will not mislead the pilot using it.

The most hopeful method of simplifying the aircraft instrument problem from the pilot's standpoint is to make functions automatic. This will lead to automatic power control where the pilot will not have to "juggle" the many factors which determine the power output of the engines and propellers. The automatic propeller has gone a long way in simplifying these operations, and further simplification will be obtained by adding in more factors in the automatic control mechanism.

In the flight instrument class, the automatic pilot greatly simplifies flight under all conditions. Since the flight instruments can also provide signals for the automatic pilot, we can expect a continuation of this combination. The automatic pilot will smooth out flying in the same way that the shock-absorber system smooths out the ride of the automobile.

Predict Qualities of Finished Parts By Studying Properties of Bar Steel

▪ Milwaukee, Dec. 3

(Summary of a paper on Predicting Engineering Properties of Steel from Cold Finishing and Jominy Test by H. N. Landis, assistant manager metallurgical engineering, La Salle Steel Co., Chicago)

INTRODUCTION of the not-so-widely known Government steel specifications and the advent of the NE steels have brought home to engineers the importance of their being able to predict the physical properties of the finished steel part from the original bar, according to Mr. Landis.

The basic raw material for cold-finished bars is hot-rolled steel bar in the nonfurnace-treated condition. As the diameter of these as-rolled bars increases, all physical properties drop, and even in the same size range there is a variation of 30,000-40,000 psi in tensile strength.

Physical properties of bar steel are thereafter controlled by normalizing, annealing, quenching, and tempering operations. Further modifications also take place during some of the cold-finishing operations themselves.

Finishing by turning and polishing has no effect on the properties of the material, but cold finishing by die drawing increases the yield point in both torsion and tension and decreases ductility, bringing about a 15-25% improvement in machinability over the hot-rolled bars.

Grinding is the third cold-finishing operation considered by Mr. Landis. In setting up engineering specifications for ground bars, attention must be directed to the cold-finishing operation that precedes the grinding. The properties of turned and ground bars are those of the hot-rolled bar, while if the bar is die drawn instead of being turned before grinding, increased yield point and decreased ductility are obtained.

In his paper, Mr. Landis also reviewed the basic procedure of the Jominy End-Quench Test and the procedure used in predicting comparative hardness from the end-quench curves. In addition, he discussed the method for predicting actual tensile strength, yield point, elongation, and reduction of area.

The Jominy Test is the best means available for comparing the relative hardenability of the old and well-known SAE steels with the new NE steels.

Although the end-quench test comparisons leave many problems unanswered, as distortion in heat-treating, impact values, and machinability, there are good reasons for stressing both the engineering values resulting from cold-finishing methods and the end-quench test procedure, because many buyers are now ordering steel by specifying mechanical properties rather than by stipulating precise chemical compositions. They specify the particular strength of hardness required, leaving to the steel makers the task of selecting a steel of suitable chemical composition.

Cold Affects Diesel Fuels

continued from p. 51

STARTING FLUID – A starting fluid was developed that permits the starting of automotive type diesel engines in less than 10 sec at —50 F. It is injected into the intake manifold during the starting operation by atomizing with a special spray gun. At subzero temperatures it was necessary to continue supplying the starting fluid for a period up to 30 sec to catalyze combustion until the combustion chamber was warmed up enough to burn the diesel fuel. In all tests, engines were equipped with crankcase oils diluted with gasoline to reduce the viscosity low enough to permit cranking. In starting equipment in the North, it was found that from 1½ to 2 oz of fluid was all that was required for a start even at extremely low temperatures.

The final answer to the proper method of operating equipment in subzero temperatures may lie in the use of auxiliary heat, special winterized fuels and lubricants or a combination of both.

Experience Suggesting Criteria for Periodic Crankcase Oil Changes

■ Southern California

(Following is a summary of the discussion which followed presentation of the paper "Crankcase Draining Periods, Plus or Minus," by C. M. Larson at the Dec. 10 meeting of the Southern California Section. Excerpts from Mr. Larson's paper appeared in the January, 1944, SAE Journal, p. 23. Mr. Larson explained that, while successful lubrication or drainage period varies "plus or minus" with locality, seasons, and so forth, one truth holds with crankcase drained oils: clean used oil means a dirty engine, whereas dirty used oil means a clean engine.)

PREVENTIVE maintenance is a major factor affecting the drain period, believes E. W. Templin, Los Angeles City Bureau of Power & Light, who said the more thorough and complete this program, the longer can be the drain period. He remarked that his company has increased the drain period from 750 to 1500 miles and in many units 2000 miles and more by means of the Faber Laboratory Crankcase oil analysis used to determine drain periods.

According to Ulric B. Bray, U. B. Bray Co., the time for draining crankcase oil is (1) when the oil is no longer able to withstand severe heavy duty conditions for which it was manufactured, or (2) when the oil has become sufficiently contaminated with foreign materials to endanger engine condition. Whichever occurs first is the determining factor, although both may occur simultaneously. His answer to the problem of oil and filter changes is, "Change the oil regardless of its appearance on a mileage or engine hour basis, which has been found by experience to be well within the useful life of the chemical additives, and change the filter whenever the oil becomes dark or scoty in appearance."

Lt.-Col. Walter C. Thee, Ordnance Department, preferred the rule "Change oil filter cartridge whenever the oil is drained, and change oil whenever the color on the dipstick gauge is black," to the advice "Drain oil every 1000 miles and change oil filter cartridge every 6000 miles," because the operator fails to have the necessary maintenance performed on the oil filter, even after it is clogged with carbon, sludge, road dust and sand. He recommended practicing this rule, to prevent excessive engine wear, until crankcase ventilators are improved and more efficient oil filters are developed.

Asserting that it is the responsibility of each operator to set the drain period according to his own particular operating conditions, R. Lyle Brace, Brace Engineering Co., Inc., said the operator must place this period at the time when the oil is still in good condition. This means that good oil must be discarded every time an engine is drained. He went on to state that a low mileage or hourly drain period is the safest in the long run, as running the engine only a few hundred miles after the oil has become unfit for further use can do more damage than the cost of several oil drains.

Clifford R. Stewart, Faber Laboratories, Inc., claimed that establishing the drain period at any point between 200 to 2000 miles in a fleet would result in two almost extreme conditions: (1) many units would be operating with oil which has become unfit for use, as they require oil change at periods between 200 and 500 miles, and (2) the oil in many units is still in good serviceable condition at the 2000-mile mark. Questioning the statement that crankcase oil analyses are not a measure of engine deposit rating, Mr. Stewart asked why these analyses, which are still the basis for establishing the quality or character of the unused oil, should not be just as efficient a yardstick for measuring the effects of service on the oil following a period of use. Referring to the saying, clean used oil means a dirty engine whereas dirty used oil means a clean engine, he declared this might mean that the more frequent the drain period the cleaner will be the drained oil. Therefore, he concluded, the cleaner the drained oil because of frequent draining, the dirtier the engine has presumably become. ■

Super-Fuels Held Less Important Than Design For Operating Economy

by R. J. S. PIGOTT
Gulf Research & Development Co.

■ Pittsburgh, Nov. 23

(Excerpts from paper entitled "Gasoline – Today's Problem, Tomorrow's Expectations")

THE first thing we are faced with in the modern prediction market is the large amount of 100-octane gas which should be available after the war. A considerable percentage of it, as now made for aviation, is substantially synthetic materials which are made at higher cost than normal gasoline. Up to now it has been necessary to make four to five times as much normal gasoline in order to get the materials for making one unit of 100-octane aviation gasoline, and it does not look as if this ratio would be greatly reduced.

We have been frequently informed that increase of compression ratios can give remarkable economies. Comparing 1931 and 1941 cars of the same design and representing the bulk of the market, the compression ratio increased from 5.1 to 6.65, horsepower increased 51%. The increase in horsepower due to increase of compression ratio was only 11%. The remainder was accounted for by improvements in design. The gain in economy during this period was nothing because it had been the wish of the American public to obtain higher performance from the car rather than higher economy. It should be pointed out that we are already experiencing serious troubles in high compression cars, 6.8 up to 7.25 from preignition rather than detonation, and also, high compression engine is much more sensitive to change of conditions.

If we want better economy from cars, the biggest gain can be made by reducing weight and frontal area of the car and considerably reducing the engine horsepower. High performance is a question of horsepower per pound of weight, and high top speed is one of horsepower per square foot of frontal area. If it is desirable to obtain economy without sacrificing top performance too much, it is possible to use two engines under the hood, one of which is used for normal operation, the second started and cut in for hill climbing or top speed. However, this system would about double the powerplant cost of the car.

Another economy measure is operation of normal engines on half the cylinders. In flat country this can show economy up to 20%, but is of little or no value in hilly country because the full engine has to be used too much. Another method is using a smaller engine running unsupercharged at normal road loads with a cut in supercharger for acceleration, hill climb, or high speed. This can be arranged so that in spite of supercharging, the octane value of the gas need be no more than the present premium grade, 82 or 83 octane number.

Still one more way of getting excellent economy is to use present general type and size of engine with a three-speed transmission, but with considerably reduced rear-axle ratios, coupled with the use of a fluid flywheel. The transmission could be of hand-operated or automatic type.

Coming back to octane rating gasoline of the future, there is very little in it for the average passenger-car driver. Truck or bus operators can probably make use of 87 or 90 octane gasoline to advantage but even a heavy duty operator cannot utilize 100-octane gas and make money on it. Also, as the octane value of the gasoline is raised, the yield goes down. That is why we should expect that, after having reduced the premium grade fuel from 82-83 down to 80, and the motor grade from 75 to 72, it will go down still further as the Army and Navy needs for 80 octane and 100 octane go up. We might even wind up with a single grade of gasoline between 65 or 70 octane. The best way to prepare for this situation is to get a steel shim of requisite thickness or an extra head gasket, and put it in the car now. At the present low driving speeds, there is no loss of economy or power. The usual expedient of cutting down the octane requirement of an engine by retarding the spark is limited in use and kills high speed performance. It is much better to reduce compression ratios by means of the head gasket and this is feasible for practically every car. As a proof of this, the writer has operated a Cadillac designed for 7.25 compression ratio and premium gasoline, with two head gaskets, at 6.25 on motor gasoline, without any trouble with the engine.

Trailer Maintenance Calls for Thorough Checking Job

continued from p. 51

should be aligned to the front axle and then the second aligned to the first by use of trammel points.

Camber is checked by rotating wheels to find wobble or poor bearing adjustment. A vertical straight edge is clamped to the center of the axle. Then a measurement is taken from the straight edge to the bottom of the rims and to the top of the rims. Total of the two top measurements should exceed the bottom by about ¾ in. on a 20-in. rim.

About SAE

Col. Joseph M. Colby

Chief of the development Branch, Tank-Automotive Center, Ordnance Department, has been promoted to colonelcy. A graduate from the U. S. Military Academy, **COL. JOSEPH M. COLBY** received his M.S. degree from M.I.T. in 1935, and is a graduate of the Army Industrial College, Army Ordnance School, and the Command and General Staff School. Before receiving his present assignment with the T-AC, Col. Colby made a tour of the Allied battlefronts. He has spoken several times before the Society and is one of the principal Army contacts with the SAE War Engineering Board.

MARTIN GARROTT, who had been assistant maintenance engineer for Pan American Airways System, Rio de Janeiro, Brazil, is now connected with China National Aviation Corp., Calcutta, India.

CHARLES G. MINOR, formerly technical consultant and head conversion specialist, member of the Appeals Board, War Production Board, Washington, is now vice-president of Welsh & Green, Inc., Chicago.

LT.-COL. WALTER C. THEE, Ordnance Department, U. S. Army, has been transferred from A.P.O. 182 to A.P.O. 9420, c/o Postmaster, San Francisco.

JOHN R. STEARNS, previously a salesman for Wilcox-Rich Division, Eaton Mfg. Co., Detroit, is now a lieutenant (jg) USNR, and may be reached c/o Inspector of Naval Aircraft, Brewster Aeronautical Corp., Long Island City, N. Y.

ROBERT R. PERRINO, motor machinist's mate first class in the Navy "Sea Bees," is now stationed at Camp Rousseau, Port Hueneme, Calif. He was formerly at Camp Peary, Williamsburg, Va.

RALPH O. SCHUMACHER has been named plant supervisor of Western Union Telegraph Co., New York City. He had previously been motor vehicle supervisor for Postal Telegraph-Cable Co., same city, before that company's merger with Western Union.

W. P. EDDY, JR., formerly metallurgical and service engineer for GMC Truck & Coach Division, General Motors Corp., Pontiac, Mich., has recently joined Pratt & Whitney Aircraft, Division United Aircraft Corp., East Hartford, Conn., as materials engineer. Mr. Eddy is chairman of the SAE Iron & Steel Committee, W.P.B., and of the AISI-SAE Hardenability Data Committee.

MAJOR-GEN. STEPHEN G. HENRY has moved from the Office of Chief of Staff, War Department, to the New Development Division, Pentagon Building, Washington.

WILLIAM R. GERBER, formerly general works manager, Dodge Chicago Division, Chrysler Corp., is now superintendent of pressed steel at Dodge Main, Detroit.

Previously research engineer at Mason Laboratory, Yale University, New Haven, Conn., **WOLFGANG E. MEYER** is now connected with Bulova Watch Co., Woodside, L. I.

LEIGHTON M. LONG, formerly chief metallurgist and foundry superintendent of Bunting Brass & Bronze Co., Toledo, Ohio, has been named assistant research supervisor at Battelle Memorial Institute, Columbus, Ohio. Mr. Long has had over 20 years research and supervisory experience in the metallurgical industries.

Leighton M. Long

E. D. WILKIN has resigned from Jacobsen Mfg. Co., Racine, Wis., as design engineer to join Butler Bin Co., Waukesha, Wis., as chief engineer in charge of Carscoop activities.

E. R. HEWITT, consulting engineer for Mack Mfg. Corp., Long Island City, N. Y., tells the story of his varied life, his many gifted relatives and ancestors, among whom were John Hewitt, furniture builder, and Peter Cooper, builder of the first American locomotive, in his recently-published autobiography "Those Were the Days."

COM. RICHARD M. OLIVER, USN, formerly inspector of naval aircraft, U. S. Navy, Washington, may now be reached c/o Fleet Post Office, San Francisco, Calif.

Formerly a development engineer for American Cyanamid & Chemical Corp., New York City, **PHILIP S. SHOWELL** is now a lieutenant (jg), E-V(S), USNR, and may be reached c/o Resident Inspector of Naval Material, Port Arthur, Tex.

WENDELL W. ROTE has entered the U. S. Navy as a warrant officer in the transportation branch. He had been superintendent of maintenance for the City of Phoenix Transportation System, Phoenix, Ariz.

MAJOR JOHN K. HAMPTON, U. S. Army Air Forces, has been transferred from Memphis to Nashville, Tenn., where he is area representative.

R. L. Vaniman, below, has been named vice-president in charge of exports for Fruehauf Trailer Co., Detroit. Mr. Vaniman, who recently resigned as director of the Automotive Division of the War Production Board, was called to Washington as deputy chief of WPB's automotive branch one month after Pearl Harbor

C. G. Krieger, above, has been appointed special assistant to Donald M. Nelson, chairman of the War Production Board. Mr. Krieger, deputy director of the Farm Machinery & Equipment Division of WPB, will have full responsibility to study and help coordinate the overall farm production and supply program

& Members . . .

TOM B. **LINTON** is now consulting engineer for Allite Mfg. Co., Los Angeles, manufacturers of plastic parts for hydraulic equipment and radio assemblies. He was formerly chief engineer of the Product & Tool Division, Buchanan Mfg. Co., Burbank, Calif.

Previously vice-president and general manager of Akron Transportation Co., Akron,

Pierre V. C. See

Ohio, **PIERRE V. C. SEE** has recently joined San Diego Electric Railway Co., San Diego, Calif., as manager of transportation.

LT. JACK I. DU BOFF has been transferred from the Office of Automotive Officer, Walterboro, S. C., to the Base Ordnance Motor Repair Shop, Columbia Army Air Base, Columbia, S. C.

W. R. BRASHEAR, formerly assistant engineer at St. Louis Ordnance District, St. Louis, Mo., has recently joined Mines Equipment Co., same city.

WILLIAM E. BARNETT, formerly connected with Glenn L. Martin Co., Baltimore, as head engine instructor in the U. S. Army Air Forces Technical Training Detachment, is now with Fairchild Aircraft, Division of Fairchild Engine & Airplane Corp., Burlington, N. C., as assistant chief inspector.

R. T. NELSON recently joined Audio Products Co., Burbank, Calif., as chief engineer and co-partner. He was previously with Hydro Aire Co.

L. A. DANSE, who had been chief metallurgist and technical adviser for Cadillac Motor Car Division, General Motors Corp., Detroit, has moved to General Motors' central office, same city, and will serve on the staff of Thomas P. Archer, vice-president of the company, where he will be concerned with metallurgical problems.

CHARLES A. WORLEY, formerly tool planner for Douglas Aircraft Co., Inc., Oklahoma City, Okla., is now in the engineering department of Autolite Spark Plug Co., Fostoria, Ohio.

The first War Department "Emblem of Civilian Service" awarded to 2200 of the Tank-Automotive Center's civilian employees went to Joseph Proske, extreme right, chief engineer, Engineering Section, Manufacturing Branch, who has been an SAE member since 1936. It was presented to him by Brig.-Gen. Walter P. Boatwright, right, chief of T-AC

LT. RAYMOND E. BROWN, U. S. Army, has been transferred from Fort Ord, Calif., to A.P.O. 7, c/o Postmaster, San Francisco, Calif.

LT. F. J. BOYLE, USNR, has moved from the Naval Air Station at Kodiak, Alaska, to the Naval Air Station at Brunswick, Me.

EDWARD C. HOENICKE, assistant general manager, Foundry Division, Eaton Mfg. Co., Detroit, has been appointed to direct, as industry consultant, the newly-created gray iron castings section in the steel division of the War Production Board. Mr. Hoenicke is chairman of the publicity committee of the Gray Iron Founders' Society.

"An investigation into production at Fairchild's plant at Burlington, N. C., died aborning after J. Carlton Ward, Jr. (above), Fairchild (Engine & Airplane Corp.) president, appeared before a House Military Affairs subcommittee and explained to the committee's entire satisfaction and education some of the difficulties attendant upon building a new airplane," reports *Aviation News* in its Dec. 20 issue. The item continues, "Ward's clear, concise and candid testimony was a revelation to some committee members who were impressed with his presentation"

R. E. PLIMPTON, formerly senior automotive engineer, U. S. War Department, Office of the Quartermaster General, Motor Transport Division, Engineering & Specifications Bureau, Washington, is now chief of the Specifications Group, Engineering-Manufacturing Branch, Tank-Automotive Center, Detroit.

C. R. TALMAGE, who had been mechanical engineer for A. Robert Snyder Co., Dayton, has recently joined Manning-Bowman Co., Meriden, Conn. Mr. Talmage is past-chairman of the SAE Southern Ohio Section.

J. F. WINCHESTER, Standard Oil Co. of N. J., who until the first of the year was an adviser to the Tank Truck Section of the Office of Defense Transportation, has been appointed consultant to Harold Arnot, the new chief of ODT's Motor Carrier Division.

turn to next page

M. B. Chittick, below, a colonel in the Chemical Warfare Service, is now stationed at Camp Detrick, Frederick, Md., where he is commanding officer. He was formerly at the War Department in Washington, where he was deputy chief of the Technical Division of the same branch

H. S. SHERWOOD, who had been sales manager for Lube-X Systems, Inc., is now affiliated with Faber Laboratories, Inc., at the New York City office, headquarters for the East Coast division of the Faber analysis service in conjunction with the U. S. Army field maintenance program.

SAE members who have recently received changes in company status are: **KENNETH DUKE SCOTT, JR.,** General Electric Co., from the engineering department at Nela Park, Cleveland, to Mahoning Glass Works, Niles, Ohio; **VERNON B. BENFER,** Lockheed Overseas Corp., from group head in charge of technical training at Burbank, Calif., to production engineer of the Aircraft Engine Overhaul Division, A.P.O. 636, New York City; **CARL F. BLAKELY,** Pratt & Whitney Division of United Aircraft, East Hartford, Conn., from installation engineer to engine operation engineer; **ROBERT W. PRATT,** Pratt & Whitney Aircraft, East Hartford, Conn., from experimental test engineer to assistant project engineer; **GEORGE H. ZUVER,** sales engineer for Wagner Electric Corp., has been transferred from the Detroit to the Cleveland branch of the company; **EDWIN CRANKSHAW,** Cleveland Graphite Bronze Co., Cleveland, from assistant chief engineer to mechanical engineer; **EMMET J. FIELD,** International Harvester Co., from sales blockman at the St. Cloud, Minn., branch, to the War Materials Division, West Pullman Works at Chicago; and **JOHN HAIEN,** director of defense training of Chrysler Corp., has been transferred from the Dodge Chicago Plant to the Detroit branch.

KEITH L. SWARTZELL, formerly fleet service manager of Shanghai Power Co., Shanghai, China, is now transport superintendent and workshop engineer for Ebasco Services, Inc., New York City.

JOHN B. CLARK, a civilian technical automotive adviser for the U. S. Army, has been transferred from the Ordnance Department at Fort Ord, Calif., to 33AAA Brigade Headquarters, San Diego.

HARVEY MORTON CRONK, a major in the U. S. Army Air Forces, has been transferred from the Materiel Center at Wright Field, Dayton, where he was chief of the Army and Navy Aeronautical Specifications Unit, to the Materiel Command Flight Test Base at Muroc, Calif., where he is commanding officer.

RALPH A. BRAIK, formerly service engineer for Detroit Diesel Engineering Division, General Motors Corp., Detroit, is now a technician in the U. S. Navy, and may be reached c/o Fleet Post Office 134, San Francisco.

DEAN C. SMITH has joined the executive staff of Fairchild Engine & Airplane Corp., New York City, in charge of development activities. A veteran pilot, explorer and aviation sales director, for the past several years, Mr. Smith has been director of transport for the Airplane Division of Curtiss-Wright Corp., Buffalo, N. Y. Prior to that he was sales manager of the organization's St. Louis airplane division.

Dean C. Smith

CONRAD I. MANDT, formerly an engineer for International Harvester Co., Tractor Works, Chicago, is now in the U. S. Army Air Forces, Spokane Army Air Service Command, Spokane, Wash.

FRANK M. BEELER, JR., who had been project engineer for AiResearch Mfg. Co., Los Angeles, is now control supervisor at Brunswick-Balke-Collender Co., Muskegon, Mich.

ALBERT G. BODINE, JR. is owner and engineering manager of Bodine Soundrive Co., Los Angeles. He was formerly project engineer for Hughes Aircraft Co., Culver City, Calif.

OBITUARIES

Curtis H. Veeder

Curtis H. Veeder, manufacturer and inventor, founder of the Veeder Mfg. Co. and director of the Veeder-Root Co., Inc., died Dec. 27. He was 81 years old.

Mr. Veeder held 95 United States patents and 74 foreign patents on a wide variety of devices, ranging from sewing machine improvements to mining hoists, electromagnetic clutches, searchlight regulators and air pumps. He also designed the first electric locomotive used on standard tracks in this country. Early in his career he started work on cyclometer designs, and by 1896 he had perfected automatic casting machines to make parts for the cyclometer. The machines have since been used for making parts for odometers, voting machines, cash registers and telephones.

A graduate from Lehigh University, where he received an honorary degree of doctor of engineering in 1939, Mr. Veeder was a member of many societies other than the SAE, including the American Society of Mechanical Engineers, the American Association for the Advancement of Science, and the American Geographical Society. He was a former official of the Connecticut Forest and Park Association, Inc.

Charles J. Marks

Charles J. Marks, 67, chief tool engineer for United Aircraft Corp. and one of Pratt & Whitney Aircraft Division's original em-

Executives and SAE members of the Cleveland Graphite Bronze Co. commended by company directors for "rendering the nation distinguished service in the design and production of vital war materials in vast quantity" are, left to right: J. J. McIntyre, vice-president, John V. O. Palm, vice-president, Ben F. Hopkins, president, James L. Myers, vice-president and Carl W. Johnson, vice-president

ployees, died suddenly Nov. 20. In charge of tooling for many of Pratt & Whitney's engines, Mr. Marks was influential in preparations for quantity production of the models that were developed just prior to World War II.

An SAE member since 1926, his early business connections were with E. W. Bliss Co. and Simplex Automobile Co. He became production engineer for the latter firm after the first World War, when it was renamed the Wright Aeronautical Corp.

Warren J. Belcher

Warren J. Belcher, 75, vice-president of Whitney Chain & Mfg. Co., Hartford, Conn., died at his home Dec. 1. Beginning his career in the employ of Amos Whitney, cofounder of Pratt & Whitney Mfg. Co., he was associated with three generations of Whitneys. Called the last of the "Yankee inventive geniuses," he originated and developed many of the chain devices now used throughout the industry, and held over 40 patents. Before assuming vice-presidency of the company, Mr. Belcher was successively plant superintendent, factory manager, and chief of engineering and research.

John Ralph Collins

John Ralph Collins, general manager of Provincial Transport Co., died recently at the age of 52. Mr. Collins had been connected with this company since 1928, although he started in the automotive service field in 1913. He became a member of the SAE two years ago.

David W. Rodger

David W. Rodger, vice-president and secretary of Federal-Mogul Corp., and prominent in the automotive industry for many years, died Jan. 4. He was 50 years old. Associated with Federal-Mogul since 1915, Mr. Rodger had recently been elected a director of the Automotive Council for War Production. He was also a past-president of the National Standard Parts Association, and was a former officer of the Automotive Parts & Equipment Manufacturers' Association.

E. R. Lederer

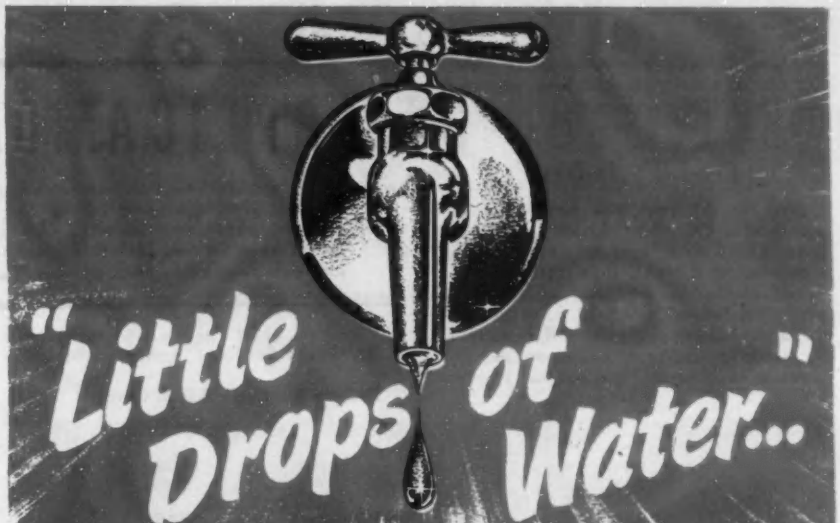
E. R. Lederer, consulting engineer for Sun Oil Co., died recently at the age of 61. A former vice-president and director of Texas Pacific Coal & Oil Co., Dr. Lederer operated and managed a number of complete oil refineries, and spent most of his career as a chemist and engineer in the petroleum field.

A native of Vienna, he received a chemical engineering degree from the University of Heidelberg in Germany in 1904 and a Ph.D. from the University of Vienna a year later.

John Motion

John Motion, superintendent in the Graphite, Paint & Lubricating Department, Joseph Dixon Crucible Co., died recently at the age of 69. Born in Dundee, Scotland, Mr. Motion graduated from the Royal Technical College in Glasgow, and started his career in that city as an assistant chemist. When he came to this country in 1897 he joined the

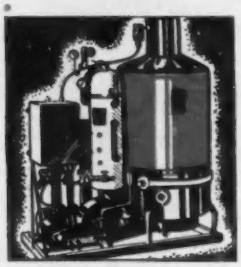
turn to next page



Just the beginning of an old nursery rhyme except to those who realize the tremendous power locked up in every drop of water . . . and that many of today's industrial and mechanical miracles had their origin in an idea for extracting and utilizing this power.

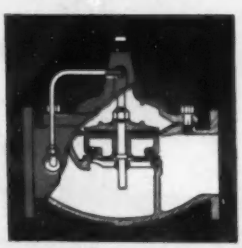
Since its inception the Clayton organization has concentrated its research and development energies toward finding new ways of harnessing the power in water. Results, that generally depart from conventional engineering practices, have produced new types of equipment that are worthwhile contributions to industry and to the war effort.

Hydraulic Dynamometers — *Clayton "Turbo Closed System" dynamometers provide all the accuracy of the finest equipment available, at a fraction of the cost and from a minimum of critical materials. Sizes from 50 to 4000 h.p.*



Flash Type Boilers — *Requiring ⅛ the space and weighing ¼ as much as conventional boilers, Clayton steam generators develop full working pressure in 5 minutes; are fully automatic; instantly adjust themselves to any load.*

Kerrick-Kleaners — *Automatically combining water with heat, detergent and friction, Kerrick-Kleaners save up to 80% of the man hours otherwise required for a wide variety of industrial and automotive cleaning operations.*



Feathertouch Valves — *Harnessing hydraulic line pressure in an entirely new way, Clayton valves solve countless liquid and pressure control problems; are positive in action; eliminate line shock; equally adaptable for manual, remote, automatic or alternate flow control.*

CLAYTON MANUFACTURING CO.

ARMY NAVY

ALHAMBRA CALIFORNIA

Valvoline Oil Co., later going to the Union Oil Co. of Calif. He had been associated with Joseph Dixon since 1908.

Fred W. Andrew

Fred W. Andrew, who had been connected with Columbia Aircraft Corp., died at the age of 69 on Dec. 25. Mr. Andrew, a member of the SAE since 1916, had attended M. I. T. His previous affiliations were with Remy Electric Co. as production engineer, Dayton Engineering Laboratories Co. as design engineer, and meter and instrument engineer for Westinghouse Electric & Mfg. Co.

APPLICATIONS Received

The applications for membership received between Dec. 10, 1943, and Jan. 10, 1944, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Baltimore Section: Arthur D. Brabbs.

Buffalo Section: Daniel Gurney.

Canadian Section: John Oswald T. Beynon, Emerson L. Chant, Harold Laurence Flynn, Milton H. Hodgson, Carlyle Maunder, John A. Morphy, George Walker Sawin, James H. Thomson.

Chicago Section: Robert F. Gasvoda, R. A. Goepfrich, John Erich Henningsen, Joseph Kim, Russell David Libert, LaVern R. Meyer, Leland B. Read, Jesse Lowen Shearer, George F. Soderling, Albin J. Stock, Sr., Charles E. Watson, Lester E. Whiteman, John S. Yule.

Cleveland Section: John Borland, Colin Carmichael, L. H. Dunham, Herbert Henry Fink, William C. Holmes, Harland G. Johnson, William James Kovelan, Oscar Walter Kraemer, Leland Melvin, Thomas E. Millard, J. Lawrence Myers, Joseph Henry Richards, John C. Sheppard, J. R. Thompson, D. C. White, Arthur E. Wolfe.

Detroit Section: Edward E. Blaurock, Harold L. Brock, Erwin F. Collins, Earl K. Cusac, Theodore James Deska, John Dutton, Lt. Theodore M. Fahnestock, Clifford B. Higgins, William H. Horn, Stephen Gabriel Maco, Dain M. Milliman, Edward Lupton Page, Harry J. McGowan, Jr., Irwin C. Moreau, George P. Nelson, H. W. Peters, George A. Pillsbury, Michael A. Remondino, Ray Russell, Robert James Saxon, Abraham S. Schachnow, Walter F. Seifert, Claud S. Semar, George W. Smith, Carl A. Stamm, M. B. Terry, F. Russell Valpey, Jack Harrington Waldner, Waldo D. Waterman, Henry F. Weiler, Sam Barlow Williams, Louis S. Wood, William Martin Z'Meeker.

Indiana Section: Eugene Elmer Hess, Miss Ruth Replogle.

Kansas City Section: Royal C. Jackson, John F. Pahl.

Metropolitan Section: Ou-Wen W. Chen, David X. Clarin, John Mark Colonas, Arnold Clarence Fields, William Gordon Forbes, Herbert W. Gundersen, John Taylor Hayford, Heyer Products Co., Inc., William H. Joachim, Francis Angus Kimmons, Augustus B. Kinzel, Joseph N. Kosinski, Frank W. Laurenson, Robert Lovell, James Wesley McKercher, George Franklin Miller, Jr., Ted C. Ning, Herbert T. Ornitz, Charles A. Pribeck, John F. Riley, Raymond J. Wood, Jr.

Milwaukee Section: Ben Daneman, G. J. Retzlaff, Paul Schnetzky, Donald A. Sutherland.

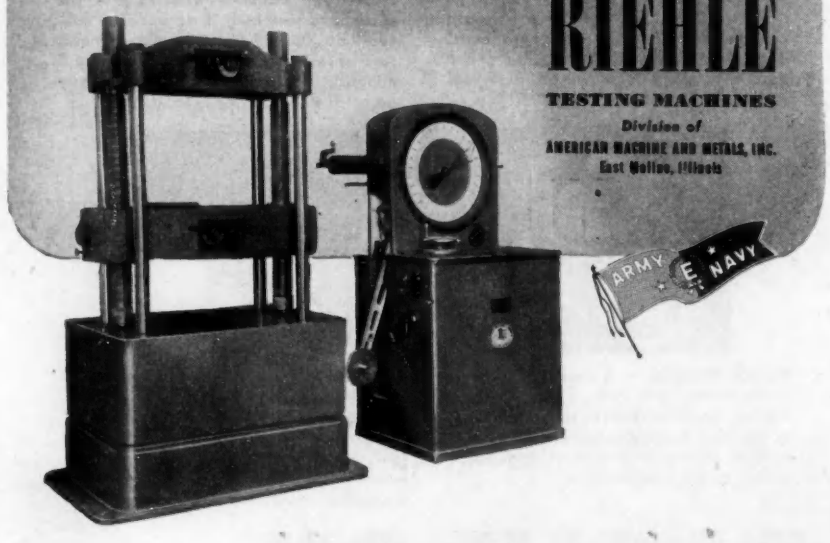
Mohawk-Hudson Group: George R. Sawin, Jr.

Muskegon Group: Walter W. Bratton, H. Leslie Casselman, Francis W. Feeney,

PRECISION
HYDRAULIC TESTING MACHINE
with Pendulum Load Indication

MORE ACCURATE, MORE DEPENDABLE FOR PRODUCTION TESTING because:

Pendulum load indicator operates on the natural laws of gravitation. ...This principle of operation is not affected by temperature changes or subject to metal fatigue....*Write for descriptive literature and quotations.*



RIEHLE
TESTING MACHINES
Division of
AMERICAN MACHINE AND METALS, INC.
East Moline, Illinois

Other Products: IMPACT TESTERS · VICKERS HARDNESS MACHINES · BRINELL HARDNESS TESTERS · MEASURING INSTRUMENTS

Albert M. Pert, Lyle L. Stringham, William VanDam.

New England Section: Alfred S. Hunt, Raymond McPherson.

Northern California Section: Lester W. McLennan, Stanley S. Moore, Roy Milligan Rushton, Irving M. Tick.

Northwest Section: Paul John Clements, Grant James, Howard Lovejoy.

Oregon Section: Claude A. Bennett, Jewell McCoy Lantz, Ralph L. Lesch, Harry Robert Ward.

Peoria Group: John P. Carroll.

Philadelphia Section: Kenneth George Roth, Robert L. Sommerville, Arthur J. Williamson.

Pittsburgh Section: E. T. Walton.

St. Louis Section: Leonard Sidney Echols, Jr., M. P. L. Love, Anthony Mikulus, Ivan Forest Weeks, Ballard A. Yates.

Southern California Section: Robert H. Bell, Bert Borcherdt, Carl A. Braman, Davenport Mfg. Co., Douglas E. Donald, James W. Eldridge, Frank W. Fink, Donald P. Frankel, Henry Thomas Graham, Thomas Brownlee Longre, Ellis D. McClelland, Donald Earl McIntyre, Donald V. Monroe, Norman C. Parrish, Donald D. Paxton.

Southern New England Section: Leslie H. Brewer, Edmund Karl Brown, Carl T. Hewitt, William Hackett Rideout.

Southern Ohio Section: F. B. Dahle, William H. Hartman, Horace G. Prall II, William Earle Stilwell, Jr., Clyde E. Williams.

Syracuse Section: Hubert E. Kaye, Jesse E. Sero.

Texas Section: Walter Budvitis, Clarence D. Maxon, Robert W. Schlumpf, W. G. Zink.

Twin City Group: Gilbert O. Holm, George S. Johnson, Martin E. Leadon.

Washington Section: William O. McGuigan, Lawrence Ross Winton.

Wichita Section: Marvin J. Gordon, Marcus B. Herscher.

Outside of Section Territory: Eugene C. Eastman, Clarence L. Gillham, Edwin A. Gustafson, Ernest W. Horvick, M. H. Kraemer, Vern Z. Perry, Valton H. Rhodes, Albert Gallus Ruegg, Walter C. Shaw, Bernard Stein, Walter C. Thomas, Glen C. Vandenberg, Alan Waddell, H. C. Waterhouse, Claude Ellswirth White.

Foreign: Stephen Blumenthal, England, Leslie Carl Greenop, British West Indies, Geoffrey William Sonnen, England.

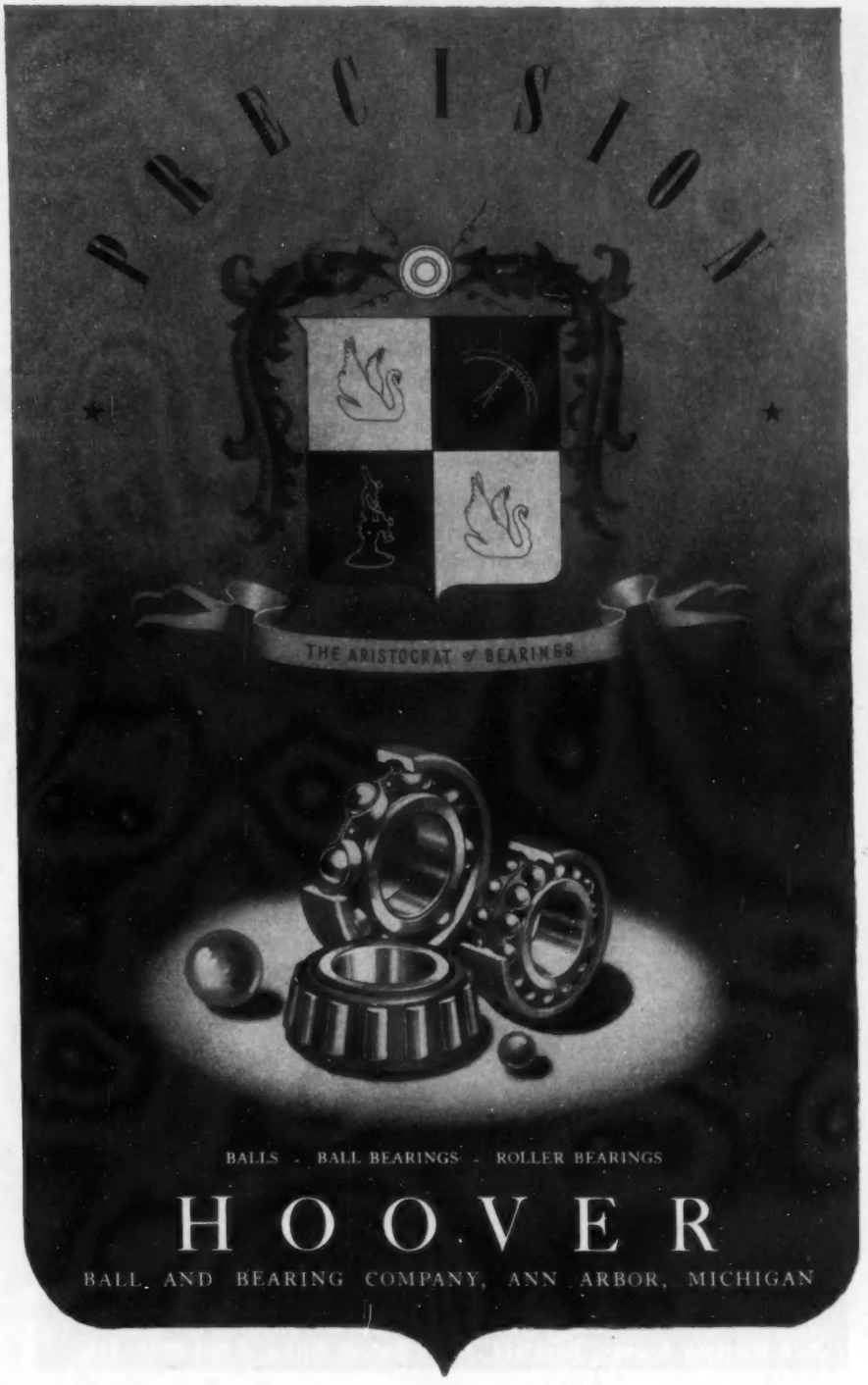
NEW MEMBERS Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between Dec. 10, 1943, and Jan. 10, 1944.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Baltimore Section: Sidney H. Fedan (M).

Buffalo Section: Dennis Hsueh-Hsi Liu (J).


PRECISION
THE ARISTOCRAT of BEARINGS
BALLS - BALL BEARINGS - ROLLER BEARINGS
HOOVER
BALL AND BEARING COMPANY, ANN ARBOR, MICHIGAN

Canadian Section: T. J. Delaney (A), Alfred A. B. Eve (A), A. G. Holmes (A), William John Ross Paton (M), Leonard George Singer (A).

Chicago Section: Walter E. Biedron (M), Leroy B. Bornhauser (M), Keith B. Hocker (J), Edward Henry Rollfs (J), Harry B. Stone (J).

Cleveland Section: William A. Benser (J), Rinaldo Brun (J), William DeCapua (M), Thomas A. Freestone (J), James A. Hilgendorf (J), George Hoffmann (M), Merle C. Huppert (J), S. Harry Norton (M), Carl Joseph Pennig (M), Carl Rolf Reuter (M), Earle C. Smith (M).

Colorado Group: Carl A. Norgren (M).

Detroit Section: Edward A. Bachle (M), Henry F. Blankenbiller (A), George Frank Cram (A), Morgan Willis Dawley (J), Elton M. Eldredge (A), Frank L. Fisher (M), W. A. Hueter (M), George H. Joly (M), Theodore C. Kuhlman (M), Dr. Charles Lipson (M), Stanley L. Lundsten (A), James W. Morse (M), Joseph N. Ulman, Jr. (M).

Indiana Section: Clifford L. Gough (M), Herman L. Hartzell (M).

Metropolitan Section: Capt. Horace Levering Arnold (SM), Matthew A. Batson (J), John Arthur Bugge (J), Courtney F. Dolan (J), Andrew G. Farkas (J), Charles L. Fleming, Jr. (J), Stanley Joseph Gut (J), W. LeRoy Hall (A), Harry Haykin (A), Russell A. Hedden (J), Bernard F. Klein (A), Ralph R. Layte (A), Stanley H. MacArthur (M), John Markell, Jr. (J), Donald M. McDowell (J), William C. Mearns (M), Leonard Meyerhoff (J), Constantine Z. Michael (J), John Edwin Miller (J), Howard Irwin Podell (J), Arthur George Pogmore (A), John F. Ross (A), John Ferguson Taplin (M), Stephen J. Tracy (M), Fenton W. Varney (J).

Milwaukee Section: Howard F. Doll (M), H. J. Hamernik (A).

New England Section: Paul V. O'Connell (A), John D. Works (J).

Northern California Section: Victor Alexander Chernivsky (J), 2nd Lt. Robert Louis Douglas (J).

Northwest Section: Ford D. Archer (A), Frank William Disch (M), Edward A. Huletz (A), V. A. Parker (A), Raymond O. Snodgrass (A).

Oregon Section: L. C. Fogg (A), Robert V. Turner (A), Leslie O. Vogel (A).

Peoria Group: Marcus A. Clements (M), Chester Wallace Thompson (J).

Philadelphia Section: William T. Clark (J), William H. Curtiss (M), Frank W. Wellons (J).

Pittsburgh Section: Joseph M. Beatty (A), Warren W. Jones, Sr. (M), William E. Walters (J), Westinghouse Elec. & Mfg. Co. (Aff.) Rep: Joseph E. Mulheim.

St. Louis Section: William C. Geiser (M), Robert Irving Goldberg (J), Herman Plew (M), Frederick A. Schick (M).

Southern California Section: L. S. Barksdale (M), J. C. Chesworth (J), Ernest Erwin (J), Hughes Aircraft Co. (Aff.) Rep: Kenneth F. Ridley, Martin Joseph Murphy, Jr. (M), Robert L. Muth (M), Walter M. Neal (M), Wesley F. Rhodehamel (A), Herbert Francis Sturdy (A), Owen Walker, Jr. (J).

Southern New England Section: Carlton W. Boller (J), Roy Bradley Fisher (J), Rex Albert Horrocks (J), J. Warren Frame, III (J).

Southern Ohio Section: 1st Lt. Robert A. Cole (J), Eldon D. Raney (A), James H. Tarkington (J), Harry Aubrey Toulmin, Jr. (J), Herbert A. Wise, Jr. (J).

Syracuse Section: Frank J. Tarnacki (A).

Twin City Group: Victor N. Albertson (M), S. Harold Beach (M), Robert E. English (J), Robert E. Larson (J).

Washington Section: Lt.-Com. Abel Abeck (M), Paul Joseph Boeger (J), Feodor F. Khimoushin (M), Lt. John P. Manning (A).

Outside of Section Territory: Harold Fredrick Brown (A), Capt. Louis M. Dessaint (A), H. B. Jossel (A), Lancaster Lens Co. (Aff.) Rep: J. N. Thompson, D. A. Lawless (M), Theodore William Nelson (M), E. H. Viele (M), Lt. Charles Barnett Wonders (SM).

MECHANICS
Roller Bearing
UNIVERSAL JOINTS

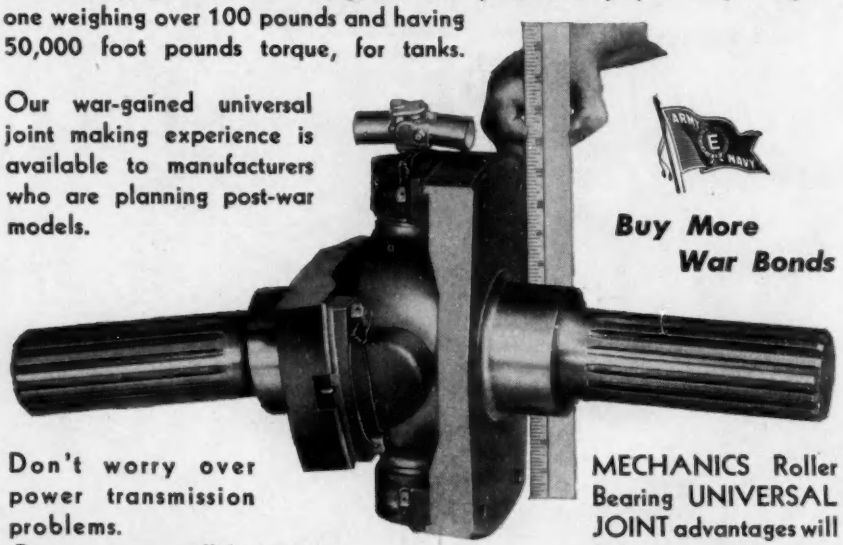
A Size and Type for Every Use

Prior to Pearl Harbor, MECHANICS had over 25 years experience building universal joints for the Nation's leading cars, trucks and busses.

Since then, we have stayed within our industry—but have broadened our range of universal joint manufacturing.

We now make universal joints for tanks, trucks, tractors, P-T boats, submarines, ships, amphibians, airplanes and other fighting machines. The MECHANICS complete line of universal joints ranges from one weighing less than ½ pound and having 200 foot pounds torque, for airplanes, to one weighing over 100 pounds and having 50,000 foot pounds torque, for tanks.

Our war-gained universal joint making experience is available to manufacturers who are planning post-war models.

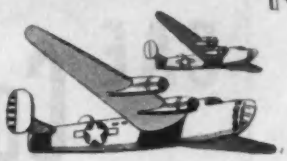
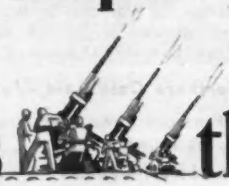


Buy More War Bonds

Don't worry over power transmission problems.
Our engineers will be glad to suggest how.

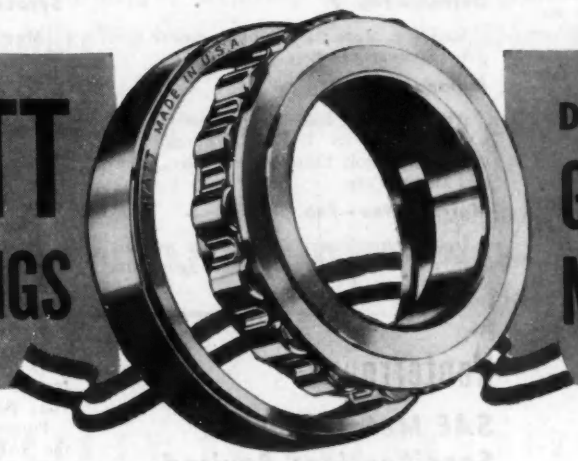
MECHANICS Roller Bearing UNIVERSAL JOINT advantages will help you get the jump on competition.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner Corporation
2020 Harrison Avenue, Rockford, Ill. Detroit Office, 7-234 G. M. Bldg.

All of Hyatt's Production now goes into planes  our men fly ...into tanks they drive... into ships they sail...into guns  they man...into equipment they need to win.

HYATT ROLLER BEARINGS SERVE SILENTLY, ACCURATELY, EFFORTLESSLY WHEREVER GEARS, SHAFTS, AND WHEELS TURN

HYATT BEARINGS



DIVISION OF GENERAL MOTORS

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

Some Facts About SAE MEMBERSHIP

NEW MEMBERSHIP PEAK: New all-time highs in SAE membership have not been at all unusual during the past several years. The Dec. 31, 1943, total, however, marks the first time SAE members have numbered more than 10,000. The actual figure is 10,023, some 22% greater than the Dec. 31, 1942, figure of 8242.

BIG RISE IN APPLICATIONS: Topping last year's figure by 42%, the number of applications received in 1943 totaled 2478. That is an average of 206 applications per month. In past years the monthly averages have been:

1942	145
1941	107
1940	89
1939	65

MONTHLY TOTALS SOAR: Previous records of applications received for a single month (203 in October and November, 1942) were equaled or broken in six of 1943's months:

January	281
March	230
April	203
September	242
October	306
November	250

Applications received in these six months totaled 1512; more than were received in any entire year previous to 1942.

Each month of 1943, except December, set an all-time record for that month in the number of applications received. (December was only 9 applications behind December, 1942.) Last year was the only one in which more than 100 applications were received every month. The lowest month was July with 117 received.

COMPARISONS: The number of applications for membership received in 1943 (2478) was greater than in 1940 and 1941 combined (2354); almost as many as in 1937, 1938 and 1939 combined (2579); greater than in 1933, 1934, 1935 and 1936 combined (2187).

More candidates applied for membership in the Society last year than there were SAE members at the start of 1917:

Candidates for SAE Membership (1943)	2478
Total SAE Membership (Jan. 1, 1917)	2121

SAE Coming Events

Buffalo – Feb. 9

Hotel Markeen; dinner 6:30 p.m. Effect of Wartime Fuel Developments on Post-War Automobiles – A. T. Colwell, vice-president, Thompson Products, Inc.

Canadian – Feb. 16

Royal York Hotel, Toronto; dinner 6:30 p.m. The Rubber Industry's Contribution to the War Effort – J. Penfield Seiberling, president, Seiberling Rubber Co.

Chicago – Feb. 8 and 15

Feb. 8 – Knickerbocker Hotel, Chicago; dinner 6:45 p.m. Farm Power and Post-War Tractor – L. B. Sperry, assistant to vice president, Engineering, Tractor and Industrial Power Div., International Harvester Co.

Feb. 15 – Turner Hall, South Bend, Ind.; dinner 6:45 p.m. War's Impact on Post-War Fuels and Lubricants – William S. James, chief engineer, Studebaker Corp., and president, SAE.

Cleveland – Feb. 14 and 28

Feb. 14 – Cleveland Club; dinner 6:30 p.m. War's Impact on Post-War Fuels and Lubricants – William S. James, chief engineer, Studebaker Corp., and president, SAE.

Feb. 28 – Mayflower Hotel, Akron; dinner 7:00 p.m. Some Aspects of Synthetic Rubber – Dr. R. P. Dinsmore, vice-president in charge of research and development, Goodyear Tire & Rubber Co.

Colorado Group – Feb. 15

Continental Oil Building Auditorium, Denver. Afternoon session 3:00 p.m. Present and Post-War Lubrication Problems – B. E. Sibley, chief technologist, Continental Oil Co. Wartime Fuel Problems of Fleet Operators – Errol J. Gay, manager, Commercial Div., Ethyl Corp. Evening session 8:00 p.m. Discussion of afternoon papers.

Detroit – Feb. 7

Rackham Memorial Building; dinner 6:30 p.m. Speaker – Hubert Scott-Paine.

Indiana – Feb. 7

Antlers Hotel, Indianapolis; dinner 6:45 p.m. Speaker – S. B. Tuttle, development engineer, Detroit Diesel Engine Div., General Motors Corp.

Metropolitan – Feb. 3

Hotel Pennsylvania, New York; meeting 7:45 p.m. Combining Round Engine and Diesel Engine to Make a Workable Aviation Engine – A. L. Bayles, director, Research & Development, Rogers Diesel & Aircraft Corp.

Milwaukee – Feb. 4

Milwaukee Athletic Club; dinner 6:30 p.m. Diesel Engines – F. G. Shoemaker, chief engineer, Detroit Diesel Engine Division, General Motors Corp.

New England – Feb. 8

Engineers Club, Boston; dinner 6:00 p.m. Plastics in War and in Peace – T. S. Carswell, director of research and development, Plastic Division, Monsanto Chemical Co.

Northern California – Feb. 5

Fairmont Hotel, San Francisco. Annual Dinner Dance.

Northwest – Feb. 4

Gowman Hotel, Seattle. Subject – Aluminum. Speaker to be announced.

Oregon – Weekly Luncheons

Every Friday, 12:00 noon at Irelands, Lloyds Golf Course, Portland.

Philadelphia – Feb. 9

Engineers Club; dinner 6:30 p.m. Subject – Helicopters. Speaker to be announced.

Southern California – Feb. 18

Hollywood-Roosevelt Hotel, Los Angeles; dinner 6:00 p.m. Subject – Aircraft Engines. Speaker to be announced.

Southern Ohio – Feb. 15

Van Cleve Hotel, Dayton; dinner 6:30 p.m. PT-Boats – Burns Darsie, chief engineer, Elco Naval Division, Electric Boat Co.; Motion Picture of Elco Boats in Action.

Syracuse – Feb. 7

Museum of Fine Arts; dinner 6:30 p.m. The Post-War Car – Roy Cole, vice-president in charge of engineering, Studebaker Corp.

Twin City Group – Feb. 10

Curtis Hotel, Minneapolis; dinner 6:30 p.m. Predicting Engineering Properties of Steel through Cold Finishing Methods and the Jominy Test – Henry N. Landis, assistant manager, Metallurgical Engineering, La Salle Steel Co.

Nonferrous

SAE Metals Specifications Revised

Extensive revisions in the nonferrous metal specifications found in the SAE Handbook are being made by the SAE Nonferrous Metals Division for inclusion in the 1944 SAE Handbook.

Purpose of the revisions is to harmonize the SAE specifications as much as possbile with those of the ASTM, the Copper and Brass Research Association, and the Conservation Division of the War Production Board.